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A TREATISE

ON THE

INSECTS INJURIOUS TO FRUIT AND FRUIT TREES

OF THE

STATE OF CALIFORNIA.

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ON THE

INSECTS INJURIOUS TO FRUIT AND FRUIT TREES

OF THE

STATE OF CALIFORNIA,

AND

REMEDIES RECOMMENDED FOR THEIR EXTERMINATION.

By W. G. KLEE,
State Inspector of Fruit Pests.

STATE BOARD OF HORTICULTURE.

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STATE OFFICE, : : : : J. D. YOUNG, SUPT. STATE PRINTING.
1888.

PREFACE.

To the honorable the State Board of Horticulture:

GENTLEMEN: I herewith submit to your consideration this short treatise on beneficial and injurious insects.

This was prepared in accordance with a resolution adopted by you at your November (1887) meeting. Some of the most destructive insects have been treated at some length, notably the fluted or cottony scale. In the preparation of this treatise, the works of Professor Riley, Professor Comstock, and that of the late Matthew Cooke were freely made use of.

I trust that this little publication will be judged charitably, as neither time nor knowledge has been sufficient to do justice to the undertaking.

Respectfully submitted.

W. G. KLEE,
Inspector of Fruit Pests.

SAN FRANCISCO, CALIFORNIA, October 12, 1888.

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ACKNOWLEDGMENTS.

I am under great obligations to Professor Riley, Professor Comstock, Mr. E. J. Wickson, and Mr. J. J. Rivers, of Berkeley, Mr. D. W. Coquillett, of Los Angeles, and especially to Mr. Albert Koebele, of Alameda, for assistance rendered me in identifying insects in the past two years. The electro cuts of the Fluted Scale, in its various stages, the Fall Web Moth, the Codlin Moth, the Parasite of the Fluted Scale, and that of two Gas Fumigators were kindly loaned by Professor Riley. To Mr. Robert J. Cooke my thanks are due for the loan of a number of wood cuts. To the "Pacific Rural Press" my thanks are also due for the loan of a great number of cuts, and other favors shown me. (W. G. K.).

INJURIOUS INSECTS.

CHAPTER I.

INSECTS SUCKING THE SAP OF PLANTS.

Aphideans—General mode of reproduction—Plum aphis—Honey dew—Woolly aphis—Remedies for the root form—Gas lime—Remedies for the branch form—Rosin solutions—Resistant stock—Scale insects—Classification of the coccidæ—Pernicious scale—Habits of pernicious scale—Aspidiotus rapax—Rose scale—Scale insects affecting citrus trees—Aspidiotus nerii—Lecanium oleæ—Remedies—Parasites—Lecanium hemisphericum—The brown apricot scale—Icerya purchasi—Rate of growth of icerya in different stages—Habits of icerya—Natural enemies—Banding of trunk—Gas remedies—Modes of treatment—The process—Doses of gas according to size of trees—Dry gas—The titus fumigator—Cost of treatment—Mealy bugs.

APHIDEANS.

The insects of this family, like the scale insects, belong to the Order *Hemiptera*. They take their nourishment direct from the trees, by inserting their beaks into the bark. Most of them work only on the soft, tender, and sappy shoots, although some, as the woolly aphis, find attachment on the wounds of older growth, as well as on the roots. These insects are remarkable for their powers of multiplication and extraordinary quickness of development, and some scientists have calculated that a single aphis may in five generations be the progenitor of nearly six millions of descendants—a statement any one watching their increase in twenty-four hours on a plum tree will hardly doubt.

Latrielle, a French naturalist, claims that an average aphis produces twenty-five young in a day; but Mr. Buckton, an authority on aphidæ, says that the highest number he has seen produced is eight, but as these are ready to increase in five days, it will be seen that the rate of increase is prodigious, and were it not for the natural checks, especially of certain insects—syrphus flies and ladybugs, in particular (see chapter on these insects)—they would literally fill the earth.

GENERAL MODE OF REPRODUCTION.

In regard to this, Mr. Buckton says:

> The extreme variety of the males of some living forms, such as the *Entomostracæ*, would seem to prove little more than that the influence of the male element sometimes is exerted at a minimum. That the male, in such cases, is not wholly absent might even show how necessary is the conjunction of primordial cells to perpetuate every species, though such a union may be deferred to very long periods. It may be pretty safely asserted that all originally proceed from impregnated ova, and at the end of their generations they again produce ova. We are in better position to state this, now that the true sexes of twelve, or more, species are known, and have been satisfactorily made out by dissection.

The egg-laying process happens at different seasons of the year according to the different genera. With very few exceptions, the egg-laying female oviposits late in autumn and dies. The male generally appears before the female. The egg when newly laid is commonly yellow, but changes into shining black or brown. They are usually found at the base of the twigs and are fastened by a gluey substance. The eggs of the aphis are very

hardy and will endure great cold, while strong caustic solutions likewise affect them but little. From these eggs, which the individuals produce at a prodigious rate, are produced the young, being born alive and ready to reproduce again after five days, until at the end of the season the cycle is finished and winter eggs again are laid.

There exists a very large number of species of aphis, each species being especially adapted to a certain family of plants, yet there are certain species of aphis common to very distinct plants. Thus, an aphis affecting the hop vine is also found on the plum, but such cases are exceptions to the rule.

Nearly all fruit trees are subject to the aphis; of the most formidable and troublesome are those of the plum and the apple.

PLUM APHIS.

The plum aphis make their appearance in the month of May, when the shoots are very sappy, and when taken in time can be checked so as to do little harm; but to do this the most thorough spraying is necessary. As one of the best remedies against them the rosin solution, given under the head of woolly aphis, is recommended.

WOOLLY APHIS.

Eriosoma lanigera. (Figure No. 1).

There is no insect so commonly met with in any old apple orchard as this, but a description to new planters will not be out of place.

In form, the woolly aphis resembles closely the green aphis, so common on roses and other plants; but its color is reddish-brown, and when crushed it yields a red juice, hence the German name *Blutlaus*, or blood louse. The insects are always surrounded by a whitish woolly substance, hence the name "woolly" aphis. Like all aphides, this species increases with astonishing rapidity, and only a few need be left on a tree to soon spread all over it. While the presence of the woolly aphis makes itself so conspicuous above ground on the branches, covering them as if with snow, yet the most serious trouble lies out of sight, at the roots, which, in our dry climate, they inhabit as freely as they do the branches, sapping the vitality of the tree to such an extent that the fruit becomes small and valueless. If allowed to go unchecked, the trees gradually die. To the apple tree the woolly aphis is what the phylloxera is to the grapevine—sucking and causing swellings and knobs all over the roots.

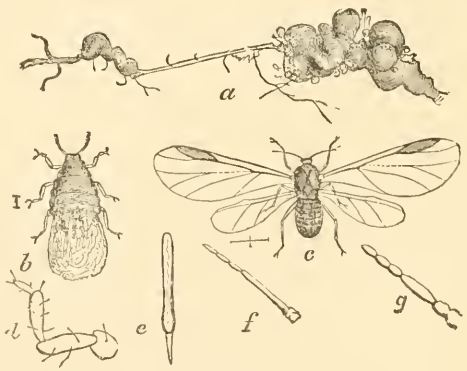


Figure No. 1.

a, the gall; *b*, larva; *c*, female; *d*, leg; *e*, beak; *f*, antennæ of female; *g*, of larva.

Naturalists maintain that there are two forms of woolly aphis, one living on the roots and the other living on the branches, but they are gradually

interchangeable. At any rate, when a tree is affected on the root it will sooner or later be affected above ground.

Remedies for the Root Form.—Liberal dressing of ashes has a tendency of discouraging the aphis, especially in moist localities, where heavy dews often moisten the ground.

Gaslime.—About one and a half to two shovelfuls placed around each tree in such a manner that it will not come in direct contact with the bark of the tree, is one of the best remedies. Add to this wood ashes placed directly around the base of the tree to the depth of one inch. Thus the migration to the upper part of the tree can be prevented.

Remedy Against the Branch Form.—For the treatment of small trees affected brushing with a rosin solution is the best; by diluting it sufficiently it can be sprayed on larger trees, and if thoroughly done it is the most effective wash I know of, being harmless to the tree.

In many instances the lady-bugs are so numerous that the aphis gain but little headway. Lady-bugs should always be protected, and persons ought to make themselves familiar with all their stages. (See chapter on Beneficial Insects.)

Rosin Solution.—One pound concentrated lye; four pounds rosin. Dissolve the lye in two quarts of water. Add the rosin; heat until dissolved and add two and a half gallons of water. Use one quart of the solution to the gallon of water. Use at a temperature of 100° F. This solution is well adapted to all kinds of trees affected with aphis.

RESISTANT STOCK.

Apple trees with very tough and wiry roots are but little affected by the woolly aphis, and some varieties exist that are altogether exempt. At the University grounds in Berkeley are two trees originally donated by the well known nurseryman, J. Rock. These trees, after five years' exposure in the midst of a badly affected orchard, have remained exempt. Such varieties must be propagated by root-grafting. No doubt other varieties are almost as good. The seedlings of Rawle's Janet and American Russet are considered resistant, and I believe those of Smith's Cider will likewise prove so. In Australia the Northern Spy bears the reputation of being exempt.

HONEY DEW

The presence of all aphis is always accompanied by a sticky, viscid solution on the leaves, which is an excretion from the body of the aphis. Invariably where this is found ants make their appearance, and the ever present connection of aphis with ants is a most remarkable fact.

Not alone do ants naturally follow the aphis, but certain species have been known to care for their eggs and colonize them on roots in their underground galleries, and I have myself seen ants in regular procession carry aphis from the top of a walnut tree down to the ground. The ants greedily lick up the honey dew, and if not excreted fast enough, they will hasten it by pricking the aphis with their antennæ.

Another significant fact connected with aphis is the black smut, which is invariably present whenever honey dew from any of the aphis or scale is secreted. This is a true fungus (*Fumago salicina*), living on this honey dew alone and not penetrating into the plant. If the aphis is removed, the smut will invariably cease to grow.

SCALE INSECTS.

Classification of the Coccidæ.

By Mon. V. Signoret, of Paris.

I. *Diaspides.*—Species covered with a scale composed of successive moultings, and of a secretion forming a shield, or sack, more or less independent of the body of the animal. Nine genera are included in this sub-family, but the scales may all be reduced to two principal types, viz.: those with rounded shields, like an oyster shell, with the larval scale in the center; and those with more lengthened shields, in the form of a large comma, or of a large mussel shell, and having the larval scale at one end.

II. *Brachyscelides.*—Species living in gall-like, or tube-like, excrescences. These insects are, so far as known, confined to Australia.

III. *Lecanides.*—Species either naked or inclosed, or simply covered with waxy, calcareous, or filamentous secretions, and in which the female, after fecundation, generally acquires an entirely different form to that which she previously possessed, and becomes fixed. Before pregnancy, they have the power to move, if necessary. A number of genera are included in this sub-family, some of which approach in some characters to the *Diaspides*, and have been separated by Targioni under the name of *Lecanio diaspides.*

IV. *Coccides.*—Species retaining to the end the body form, with all its joints distinct. They never become necessarily fixed, and are either naked or more or less covered with waxy or spumous matter, arranged generally in filaments.

In summing up the chief characteristics of the coccidæ, I give Mr. Maskell's words:

The first principal character separating the coccidæ from other *Homoptera*, and distinguishable without microscopic examination, is the absence of wings in the *female* in all stages of their existence.

The second principal character is the absence of any apparatus for feeding and digesting in the *male.*

From these two characters it follows that the females can only extend their operations by, at the best, crawling from plant to plant, or by being carried by birds, or other agencies. Also that the males cannot enjoy more than a very short existence, their work being entirely confined to impregnating the females. Hence, in an endeavor to destroy these insects, the males may be disregarded, and the females attended to.

PERNICIOUS SCALE.

Aspidiotus Perniciosus. (Figure No. 2.) (Comstock.)

This is one of the worst and to-day the most widespread of the species of scales which are found preying on deciduous fruit trees in California. The work of this species is generally readily distinguished from other spe-

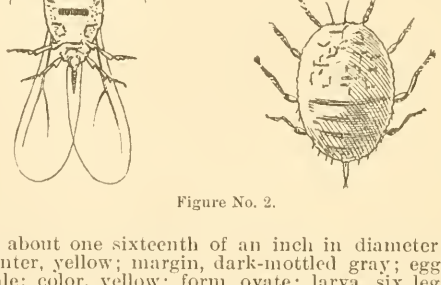


Figure No. 2.

Description.—Scale, about one sixteenth of an inch in diameter (scale of male insect elongated); color, center, yellow; margin, dark-mottled gray; eggs, thirty to fifty produced by each female; color, yellow; form, ovate; larva, six legs; two antennæ, six-jointed; two anal setæ; body, color, yellow; form, oval. Male insect (perfect), winged—wings nearly transparent; body, color light amber, with dark-brownish markings: antennæ, ten-jointed (hairy), and stylet nearly as long as body.

cies of scale by the red blotches which are formed wherever it stings any part of the tree—either branch, leaf, or fruit. These red blotches are more pronounced in some varieties than in others. When the scales are present in large numbers it causes a complete discoloration of the bark clear to the sapwood. This scale, like others, has its preference among the deciduous fruits, which it affects most severely. The apricot is the only one which, it may be said, is proof against it; certain varieties of cherries and plums are but little affected, the reason being, probably, that the bark is too compact for the scale to pierce it with its proboscis.

Plate I shows the appearance of the insect and its work on fruit, leaf, and branch.

HABITS OF PERNICIOUS SCALE.

It is generally accepted as a correct statement that this insect has three distinct broods; one in June, one in August, and one in October, at which times all the scale eggs are supposed to hatch. As might be expected, the time for these hatchings varies somewhat, according to climate and locality, a warm location hastening the development. But what is of more importance is, that all the insects evidently do not hatch out at once. During most of the time of the growing season there can be found young insects crawling around, though certainly at the periods stated they are most numerous. Yet, enough will linger along between every two of these periods to prevent summer washings to be thorough remedies, as the old scales are too well protected to be killed by anything that can be applied in the summer. I believe this is the reason why persons have been so unsuccessful in their treatment against these insects, and hence I am of the opinion that winter treatment, when we can apply remedies strong enough to kill the protected insects, is the best time to accomplish the desired result. One most important point to be considered in spraying is the size of the tree. While it is a comparatively easy thing to reach every part of a small tree, a large tree, particularly one with rough bark, it is almost impossible to cover with the spray.

THE GREEDY OR WHITE PEAR SCALE.

Aspidiotus Rapax. (Comstock.)

This species (Figure No. 3) affects many kinds of trees, deciduous as well as evergreens. It is easily confounded with a closely allied species, *Aspidiotus convexus.* This was probably imported.

Figure No. 3.

Description.—Scale, about one sixteenth of an inch in length; form, ovoid; color, drab; larva, less than one hundredth of an inch in length; two antennæ, six-jointed; two anal setæ. Female, bright yellow. Male, winged. This insect is found in many places along the coast. It infests, chiefly, pear trees, hence its name. It is distinguishable easily from the *Aspidiotus perniciosus* by its whitish-yellow color, contrasting with the dark color of the latter. And another point of difference: the white pear scale leaves no special mark where it has been, while the *Aspidiotus perniciosus* almost invariably is followed by red marks.

Generally, this scale has only one brood in the season, but I have found them breeding on pears in the storehouse during the winter. As compared with the pernicious scale, it is of little danger, owing to its slow breeding propensities.

Aspidiotus convexus resembles this form closely in habit and outward appearance. It is slightly more convex, and is best distinguished by microscopic characters.

THE APPLE BARK LOUSE, OR OYSTER SHELL SCALE (Figure No. 4.)

Aspidiotus Conchiformis (Gmelin).

Mytalaspis Pomicorticis (Riley).

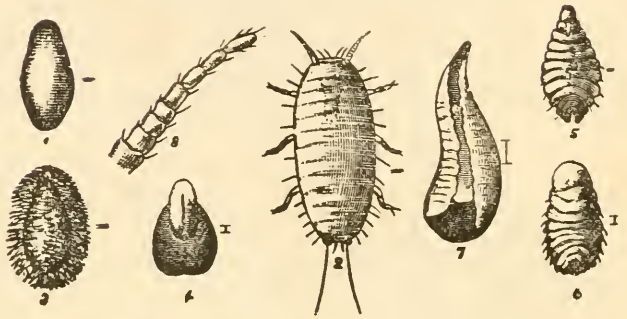


Figure No. 4.

This is one of the few insects which the Northeastern States have in common with us. Like the preceding one, it has only one brood during the season. It affects the apple chiefly, although sometimes the pear, also. It is confined chiefly to the coast counties, but is also found in other places, as San Joaquin Valley. Owing to the thickness of the armor, it is one of the most difficult of the scales to exterminate.

Description of Figure No. 4: 1. Egg; 2. Young insect (larva); 3. Appearance of secretion as it hardens and forms shell over body of insect; 4. A form of the scale before it reaches maturity; 5 and 6. Appearance of insect after casting skin, limbs, and other appendages; 7. Scales (cover) at maturity; 8. Antennæ. All of these figures highly magnified. Description of insect, etc.: Eggs, number under each scale, thirty to seventy-five; length, one one hundredth of an inch; form, irregularly ovoid; color, snow white, when near hatching, yellowish. Larva: Length of body, one one hundredth of an inch; form, ovoid, three times as long as wide: color, pale yellow. Antennæ, sometimes six-jointed, but generally seven-jointed. Anal setæ, two, about two thirds as long as body. Male insect (perfect): Length, one forty-fifth of an inch; color, flesh-colored gray; abdomen and thorax, about same length as seen from above; wings, nearly transparent. "The last joint of abdomen narrowed into a large tubercle bearing four bristles on the under side, and sending forth the genital armor in the form of an awl-shaped stylet as long as abdomen."

Remedies.—For a number of years I have tried to find an effective remedy against this scale. I have tried concentrated lye, one pound to the gallon, with the effect of damaging the trees. Finally, one half pound of lye and one half pound commercial potash to one gallon water was used last winter, and applied to the orchards on the experimental grounds of the University. The success was very marked. No damage was done to any but a few trees that had started prematurely. With various summer washes on this scale, I accomplished but little good.

ROSE SCALE.

Diaspis Rosæ. (Sandberg.)

Figure No. 5.

The rose scale is easily recognized from the other more common scales by its giving the parts affected a white, almost mildewy-like, appearance. This is due to the massing together of the scales, which are pure white, very thin, and like paper. (Figure No. 5.)

The scale of the female is circular, snowy white (or according to Signoret, yellowish white), with the exuviæ, light yellow, and upon one side; the first skin is naked, the second usually covered with secretions. Female is elongated, resembling a mytilaspis more than a diaspis. The head and thorax comprise the larger part of the body. The abdomen is very distinctly segmented, especially on the sides. Scale of the male resembles that of other species of diaspis, in being, long tricarinated, and white, with the larval skin at the end. The male is of a reddish white, with the wings white, the veins of the wings rosy. The venta is a little darker. The style equals the abdomen in length; antennæ and feet yellowish, slightly pubescent. (Signoret.) The rose scale infests, besides roses, various fruit bushes, especially blackberries and raspberries.

Remedy.—For raspberries and blackberries the cutting down of the canes to the ground should be adopted, and the stumps sprayed or washed with one of the solutions recommended under the head of general remedies for scale insects.

OLEANDER SCALE. (Figure No. 6.)

Aspidiotus Nerii (Bouché).

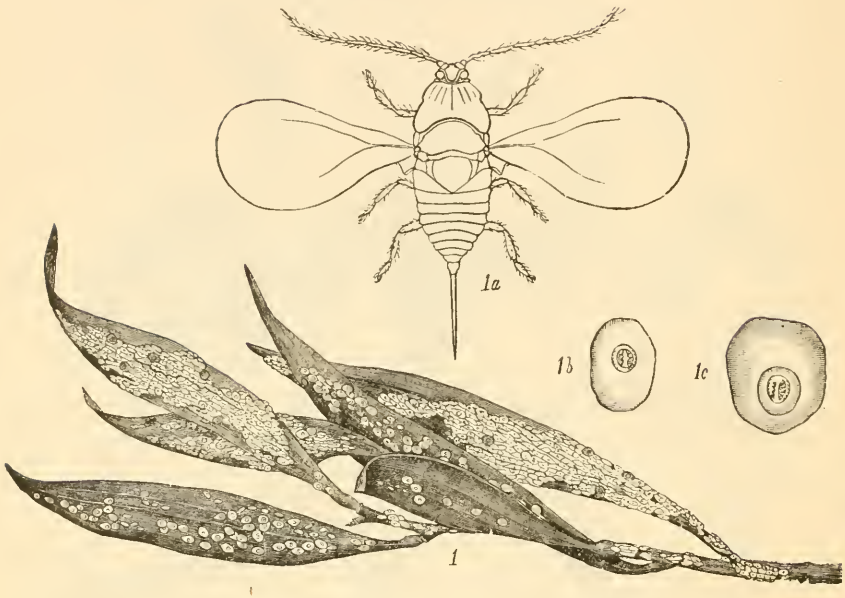


Figure No. 6.

1.—Leaves and twigs infested with the scale. *1 a.*—The male insect greatly magnified; color, yellow and brown. *1 b.*—Scale of male very enlarged; color, white. *1 c.*—Scale of female highly magnified; color, whitish or gray.

The female is of a whitish color and nearly circular; measures one line in diameter; exuviæ, or cast skin, yellowish and near the center. Male scale white and not as circular as that of the female; egg, light yellow; larva, yellowish white; length, one eighty-fifth of an inch. Female, light yellow with darker blotches; abdominal segments appear as a pointed projection at one end of the circle. Male insect, body yellowish with dark markings.

This scale affects a great many trees, especially evergreens. Lemon trees become badly affected by it and the fruit is somtimes completely covered with it. Among others the olive is also subject to it, and we have seen trees badly infested with the insect. The fruit of the olive when infested does not mature well, and wherever a scale is found a green blotch shows its appearance. As this is the only scale affecting the olive in the dry interior valleys, it is important that it should be guarded against.

SCALE INSECTS AFFECTING CITRUS TREES.

RED ORANGE SCALE. (Figure No. 7.)

Aspidiotus Aurantii (Maskell).

The following description is taken from the report of the late Mr. M. Cooke to the Board (see report of 1881).

Scale, matured, one twelfth of an inch in diameter (in a few cases it exceeds this); color, center, yellow, margin, light brown; eggs, from twenty to forty under each scale; form, ovoid; color, bright yellow; antennæ, six-jointed. Female insect: color, yellow. Male insect (perfect), winged, about one forty-fifth of an inch in length; wings clear, nearly transparent; color of body, amber yellow, with slight dark markings; anal stylet appendage nearly as long as body.

In some parts of Los Angeles County, also in Sacramento City and about Marysville, a distinct variety of red orange scale is found. According to the best authority, it cannot be considered specifically distinct from the *Aspidiotus aurantii*, yet its appearance and manner of attack are so different that I have thought it worthy of a special plate. The difference of opinion in Los Angeles County as regards the efficacy of certain remedies, and also as regards the more or less dangerous character of the red scale, is doubtless due to the fact of the two varieties being confounded. Of the two the first named or true type must be regarded as the most dangerous. The appearance of trees infested with this pest is very striking, very much resembling those diseased from other causes, such as bad drainage, the leaf representing a mottled appearance, a light blotch around the scale contrasting with the natural green of the leaf. The branches are but little troubled, but the fruit, like the leaf, becomes completely covered with the insects. An orange tree infested with this scale gradually becomes sickly and languishes, though I have never seen any that were actually killed by this scale.

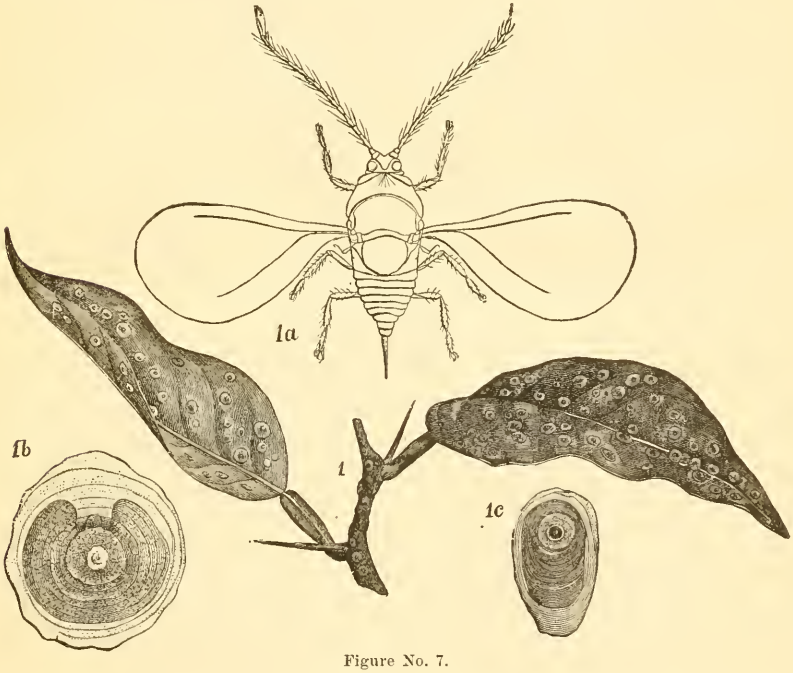


Figure No. 7.

The chief difference between these two varieties, if they are not to be called species, is that of color, the latter being of a much paler yellow than the true type. Trees imported from Japan are often infested with this form, and the probability is that it was imported from that country, while the other, or true form, came from Australia. Where this variety is it is very destructive. Plates II and III show the appearance and characteristic work of these two forms.

BLACK SCALE. (Figure No. 8.)

Lecanium Olea (Bernard).

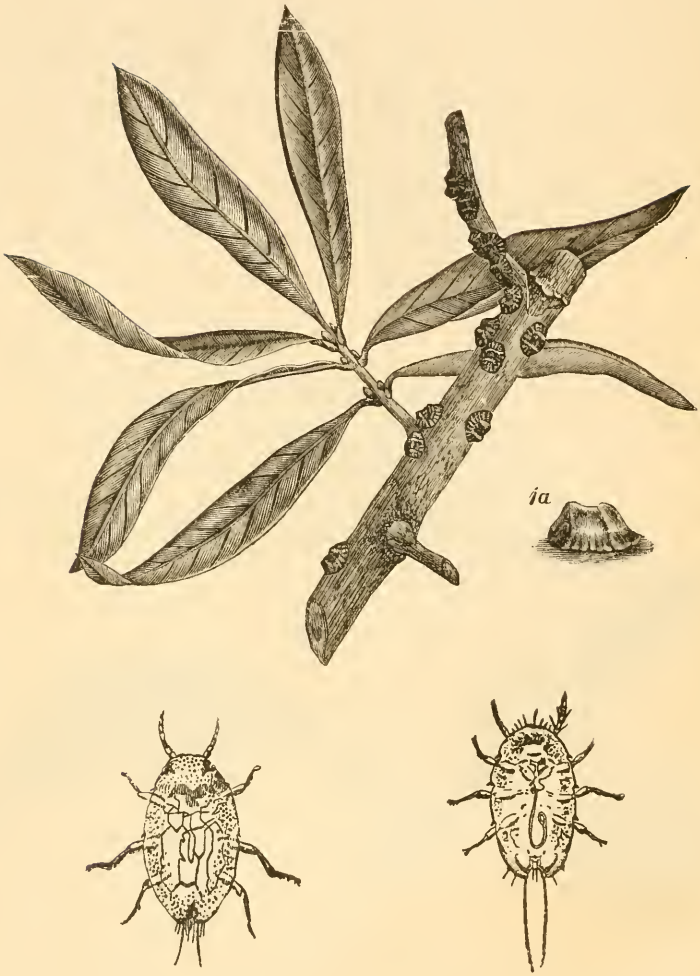
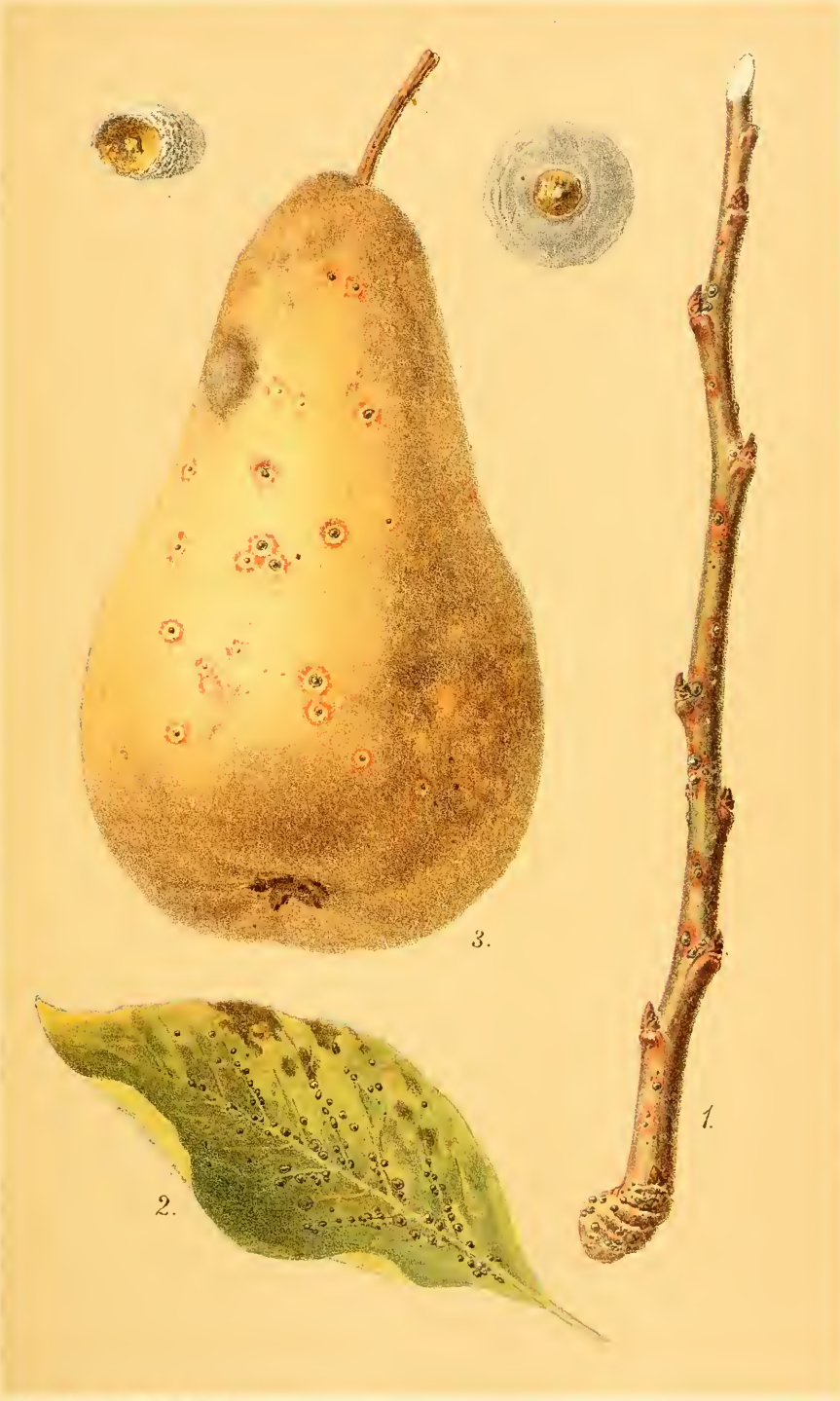


Figure No. 8.

Description.—Dark brown, nearly black, in color; almost hemispherical in form, often however, a little longer than broad; average length, from 4 mm. to 5 mm.; average height 3 mm.; dorsum, the latter dividing the body into three subequal portions (frequently the longitudinal ridge is more prominent between the transverse ridges than elsewhere, there forming with them a raised surface of the shape of a capital H). The body is slightly margined, the outer part of the disc, with many, having eighteen to twenty small ridges, which extend from the margin half way up the center of the dorsum. The antennæ are long and eight-jointed, the two basal joints short, joint three longest, joints four and five equal and shorter, joints six and seven equal and still shorter, joint eight with a notched margin and almost as long as joint three; legs, rather long and stout, the tibia being about one fifth longer than the tarsi; egg, long and oval in shape, .04 mm. in length, yellowish in color.

Newly-Hatched Larvæ.—There is nothing very characteristic about these. They are flat and their antennæ six-jointed.

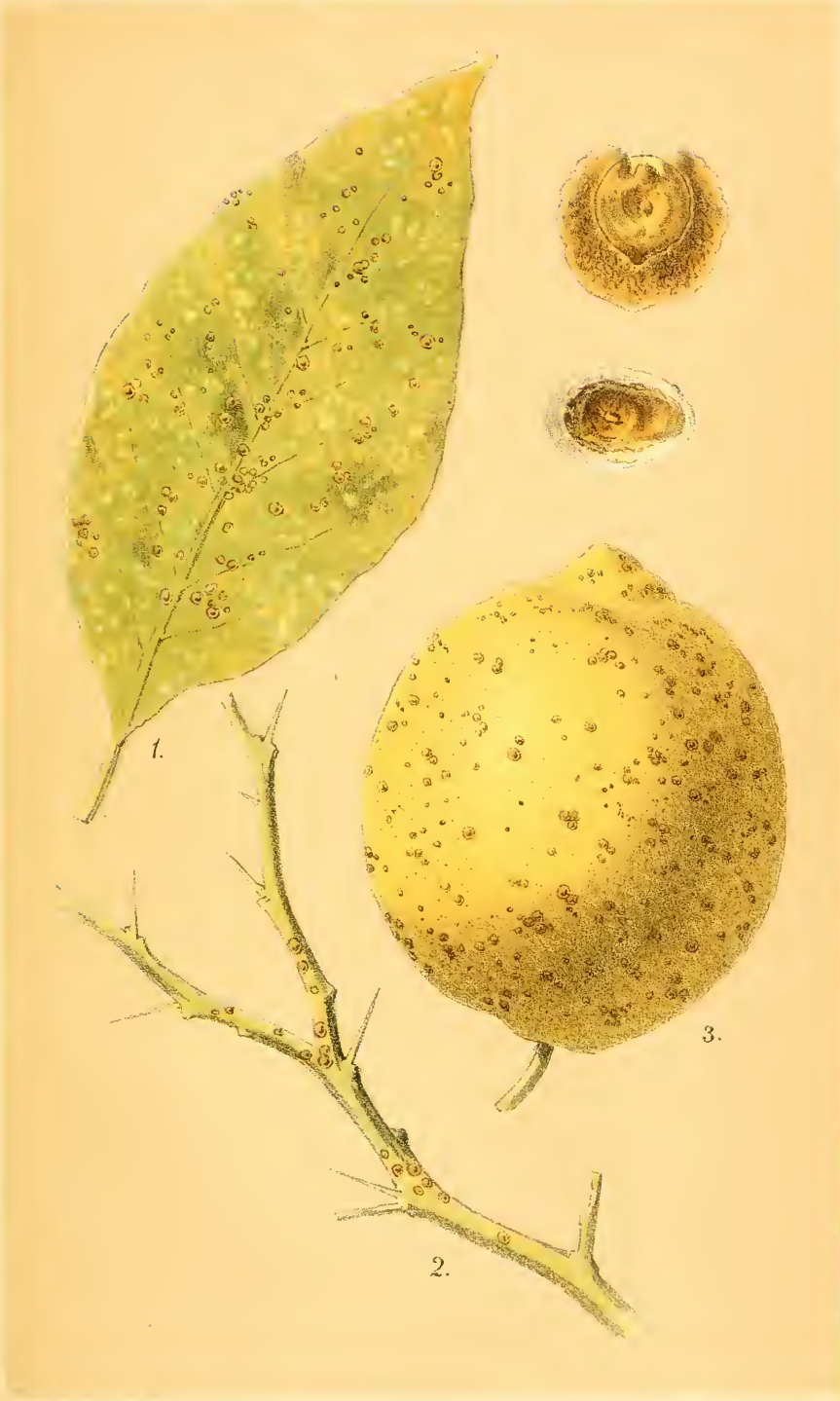
PLATE I.



Aspidiotus Perniciosus (Comstock.)

PERNICIOUS SCALE

PLATE II



Aspidiotus Aurantii

RED ORANGE SCALE (Japanese T[illegible])

PLATE III.

Lith. Britton & Rey, S. F

Aspidiotus Auranti (Maskell.)

RED ORANGE SCALE—TRUE TYPE (Australia.)

PLATE IV.

Lith. Britton & Rey, S.

Icerya Purchasi (Maskell.)

FLUTED OR COTTONY CUSHION SCALE

REMEDIES.

The black scale infests deciduous trees as well as evergreens, and is especially troublesome on the olive. During the winter they may easily be destroyed by the same washes recommended for the pernicious scale, half the strength being sufficient. On the olive it is much harder to kill, and so far I have not succeeded in finding anything that would kill nearly grown insects without damage to the tree. Kerosene emulsions have been made largely with Mr. E. Cooper, but his recent experience warrants great care in the selection of oil. Personally, I favor the sulphide of soda soap recommended for scale insects generally.

Parasites often destroy 50 per cent of this scale, especially the *Tomacera californica*. Drying winds are also a great check on their spread.

SOFT ORANGE SCALE. (Figure No. 9.)

Lecanium Hesperidum (Linn).

Probably imported from the Mediterranean.

Figure No. 9.

Description of Scale and Insect.—Scale, ovoid, a little wider at one end than at the other; length, from one twelfth to one seventh of an inch; color, dark brown on convex part, and a lighter brown surrounding margin; it has two indentations on each side, and one on posterior end; eggs from seventy-five to one hundred and twenty-five under each scale. Larva, length about one ninetieth part of an inch; color, yellowish, slightly mottled; seven-jointed antennæ; two anal setæ as long as body. The viscera can be readily seen through the scales while maturing; color of viscera, yellowish red; male, winged.

This species of scale is found in many of the orange growing sections, where it infests lemons and oranges alike; although the individual insects are easily killed, the manner in which they cling together makes it more difficult. In Los Angeles, where the scale insect proved so very formidable, at one time so destructive that, according to Alexander Craw, Mr. Wolfskill threatened to abandon orange growing. It does not now trouble the trees much, owing to the presence of two parasites, which have nearly destroyed it altogether. It is found sparingly in the foothills of the Sierra Nevada, but does not seem to gain much headway.

COTTONY GRAPE SCALE. (Figure No. 10.)

Lecanium Vitis.

This scale infests grapevines, and from the cottony excretions which so abundantly surrounds its eggs, has been called the *cottony grape scale*. It has more than once been confounded with the dreaded *Icerya purchasi*, from which it is most easily distinguished, the body of the latter being soft

Figure No. 10.

and fleshy, while the grape scale is horny, like most all lecaniums in mature state. This insect does not seem to increase, and has never been very troublesome. A gentleman of San Diego has lately made the observation that it is attacked by a native species of ant. Probably this is the check that prevents their increase.

FILBERT SCALE. (Figure No. 11.)

Lecanium Hemisphericum.

The late Matthew Cooke has in his work on injurious insects a scale insect called the "filbert scale," which is found on various trees, but in my opinion originally spread from the live oak. So far I am not aware that it has proved anything formidable; it would doubtless yield to the same remedies used for the black scale.

Figure No. 11.

I copy this description from Mr. Cooke's book:

Eggs: Length, one eighty-fifth of an inch; width, one half; color, pinkish; from seventy to one hundred laid by each female. Larva: color, reddish; length, one seventy-fifth of an inch. Antennæ: Seven-jointed, anal seta present. The females have the power of locomotion for some time. When young, they are of a reddish color, changing to a light brown, finally becoming dark brown when they reach maturity. From the common black scale they are easily distinguished by the absence of the ridge in their back—the shape of the letter H.

THE BROWN APRICOT SCALE.

Lecanium Species.

This species has to my knowledge not been described, and specimens were forwarded some time ago to an eastern gentleman making this group a specialty, but nothing has been heard from him. As it has been spreading lately in the prune districts of Santa Clara, I shall attempt to describe it in such a way that it will be recognized.

In general appearance this lecanium is very similar to the soft orange scale, with which it has been confounded. Its most striking difference is this: The *L. Hesperidum* is viviparous, that is the young come forth from the adult direct, and eggs are not seen. In this case the eggs are a very conspicuous feature. They are present in immense numbers, and the empty egg cases remain under the scale. They are surrounded with a mealy powder, and this often adheres to the branch, leaving a white mark the shape of the scale. The scale is boat shaped, when reaching maturity somewhat wrinkled; the color is a shiny brown, darker in the center, lighter at the edges. A full large-sized scale has a length of a quarter of

an inch, and a width of one eighth of an inch. The eggs generally hatch in May and June (this season in June), and the main brood is produced in a few weeks. The young are similar in shape to the *L. oleæ*, but very transparent; they are quite active and scatter all over the leaves and young branches, causing an enormous exudation of honey dew, which invites the black fungus *(Fumago salicina)*, and has a very serious influence on the development of the fruit. The young do not increase much in size the first season, but with the rise of sap in the trees in spring augment rapidly in size, and in April and May cover the branches, appearing as bead-like projections along the branches. There is evidently only one brood in the year.

This scale attacks nearly all kinds of deciduous fruits, but seems to be especially adapted to the prune and apricot.

I have not observed any parasites on the scale, but have been told of signs of such.

As it is one of the few scales attacking the apricot I have given it the name of the brown apricot scale; some person in Santa Clara has called it the mealy scale.

For remedies see general remedies for scale insects.

WHITE COTTONY SCALE.

Icerya Purchasi (Maskell).

Fluted Scale (Professor Riley).

Cottony Cushion Scale (California).

Australian Bug (Cape Town, Africa).

Under these various names is this, one of the veritable pests to orange growing, known in different sections. It would be advisable to reduce all the names to one, and I favor the name of fluted scale, proposed by Professor Riley. Suffice it to say, that this insect has existed in San Mateo County since 1868, whence it is supposed to have come from Australia. It is now found in a number of counties and steadily spreading.

Description.—Plate IV will give the reader a good general idea of the fluted scale. Figure 1 represents a branch of Japanese orange, natural size, covered with the insect in its various stages. Figure 2 represents a full grown female, much enlarged, with the egg sack laid open, showing eggs and young insects just hatched. Figure 3 represents a full grown female larva, enlarged.

The following detailed scientific description is borrowed from Professor C. V. Riley's report:

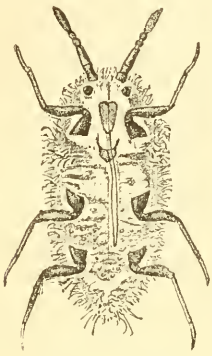
The Egg (Figure 12).—The egg is quite smooth, elongate-ovate in form, and is of a deep orange-yellow color. It measures about 0.7 mm. in length.

The average number of eggs laid by the female varies according to the vigor of the individual or the condition of the plant upon which she dwells, prolificacy diminishing in proportion as the plant is badly infested—a general law among coccidæ. Over eight hundred eggs have been counted in a single egg mass by Mr. Coquillett, while Mr. Koebele has counted in a single egg mass, which, by the way, was found upon nettle (*Urtica holosericea*), nine hundred and forty eggs and seventy-two young larvæ, while one hundred and twenty-three eggs yet remained in the dead body of the female, making a total of one thousand one hundred and thirty-five eggs from the single female.

The time required for the eggs to hatch after leaving the body of the female varies with the temperature. In the winter time the sacs are usually filled with eggs, while in the hottest part of the summer seldom more than one or two dozen will be found in each sac. Some collected by Mr. Coquillett on the eighteenth of March did not hatch until the tenth of May, but in midsummer hatching is only a matter of a few days.

The Female Larva—First Stage (Figure 13).—The newly hatched female larva (and probably the male is identical with it at this stage of growth, since we have not been able to separate them into males and females) is red in color, inclining somewhat to brown. The body is ovoid in outline, being flattened beneath and convex above. The antennæ are long and six-jointed. Joint one is short and stout, and as broad as long; joints two, three, four, and five, subcylindrical and subequal, much more slender than joint one, and twice as long as broad; joint six is as long as four and five together, and forms a long club, at base equaling joint five in diameter, but broadening out to twice its width at tip. The basal portion of the club is sometimes distinctly separate from the rest, forming an additional joint. All joints have a few sparse hairs, and the club, in addition to several short ones, bears near its tip four very long ones, each of which is considerably longer than the whole antenna. The legs are thin and brown in color. The coxæ and femora are moderately large, while the tibiæ and tarsi are long and thin, the terminal joints of the latter

Figure No. 12.



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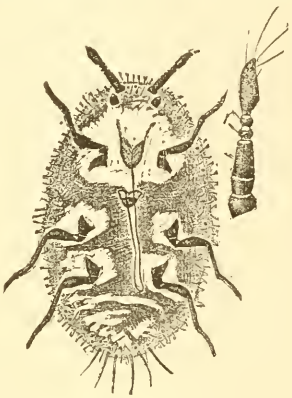

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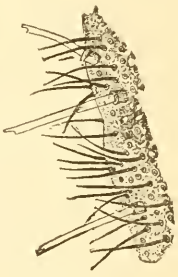

Figure No. 15.

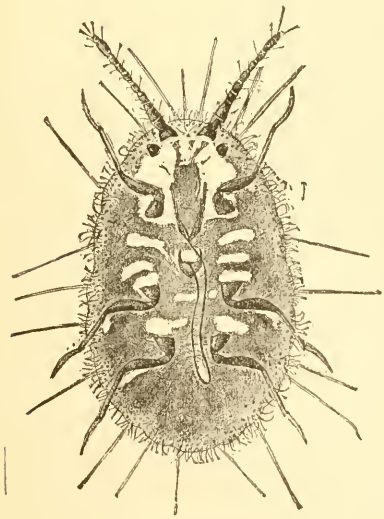

Figure No. 16.

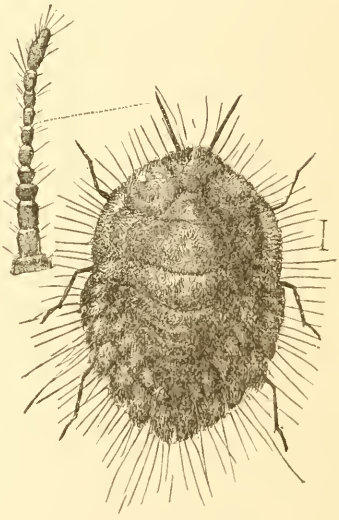

Figure No. 17.

Female Icerya, from Egg to Adult Form.

bearing several long hairs. The upper digitules are represented by simple hairs, but the lower ones are present and are bent near the base. The eyes are prominent and are each mounted on a short tubercle. The mentum is broad and apparently two-jointed. The rostrum is broad at base and the rostral setæ are not very long. At the tip of the rounded

abdomen are six small tubercles, three each side of tip, each of which carries a long, stout hair, which is as long as the whole body. The body above shows six rows of secretory pores, four along the middle and one on each side. More or less regular rows of hairs alternate with these pores.

Female Larva—Second Stage.—According to Maskell and Comstock, there are but three stages of growth in the female after hatching, and these are readily distinguished by the number of antennal joints; the larva of the first stage having six, that of the second nine, and the adult eleven. Messrs. Coquillet and Koebele came to the same conclusions, and all have overlooked a form which we have found quite abundantly among the material we have studied, and which seems to constitute an intermediate stage between the so called first and second, and which is, of course, produced by an additional molt which we have personally observed in the field. Hence the so called "second stage" of these authors becomes third, while the adult female is fourth instead of third, and there are three molts instead of two.

This new intermediate form (Figure 14) differs from the female larva of the first stage in the following respects: It is much more rounded and of a stouter general appearance. The antennæ have the same number of joints, six, but their relative proportions are quite different. The antennæ, as a whole, are relatively much shorter. Joint one is short and stout, its length equaling its breadth; joint two equals joint one in length, but is not quite so broad; joint three is as broad as joint two, but is twice as long; joints four and five are equal in length and width, each narrowing somewhat at base and tip, each considerably narrower than joint three, and each of the same length as joint two; joint six (club) is of an irregular shape—at base it is as narrow as joint five, but it broadens until it is slightly wider than two or three, and its tip is narrowed again; its shape is that of an irregular rhomboid, with rounded angles and sides, the acutest angles at base and tip. The antennæ carry about the same number of hairs as in the first stage, but those homologous with the four very long hairs of the club in that stage are in the second stage but little longer than the other antennal hairs. The eyes do not appear on the margin of the body, and are only seen on a ventral view. The legs are proportionately much shorter, and the femora are stouter; the trochanters are broader distally, and consequently form a broader triangle in shape. The six tubercles at the anal end of the body are still present; but the hairs which they bear are much shorter. The secretory pores are no longer arranged in rows, but are scattered sparsely over the back and under the sides. The back is more hairy, and the short black hairs occur in irregular tufts.

Female Larva—Third Stage (Figure 15).—That which has heretofore been considered the second stage, and which, as we have just seen, is the third, may be described as follows:

The body is broadly oval in shape, and reddish brown in color, but is soon obscured more or less by the thick, curly, cotton-like excretion. The antennæ are nine-jointed instead of six, and are subcylindrical, tapering somewhat from base to tip. Joints four, five, six, seven, and eight are subequal in length, and each is about as long as broad; joints two and three are broader and considerably longer; joint one is like the corresponding joint in the previous stage; joint nine (club) is a suboval joint, proportionately much smaller than in the previous stages; it does not exceed joint eight in width, and it does not equal joints seven and eight together in length. The long hairs of the club are proportionately quite short. The insect, as a whole, is much more hairy than in either of the previous stages. The hairs are short and black, and show a marked tendency to grow together in tufts; even when their bases are well separated, their tips turn toward each other, or toward the common center of a group; they are quite thickly scattered over the thorax, but less so over the abdomen; all around the edge of the body they appear in close tufts, and the concentric subdorsal ring of tufts which is so prominent in the next stage is plainly seen in this. The secretory pores are scattered irregularly all over the back, and are more numerous than in the previous stage; they also occur under the lateral edges of the body. They are small and circular, and seen directly from above have a double outline, indicating a circular central orifice. Around the edge of the body is a row of much larger pores, brown in color, which protrude from the body, masked by the lateral tufts of hairs, each with a circular crown or lip at tip, from which proceeds a long, fragile, glassy tube. (Figure 16.) The legs and feet are a little stouter than before, the tarsal digitules are shorter, and their enlarged tips quite indistinct. The six anal hairs are still present, though hardly noticeable as they protrude from the mass of shorter hairs.

The Adult Female—Fourth Stage (Figure 17).—Immediately after the molt by which the insect passes into this stage, it is free from the waxy excretion, and presents a broad, oval form, flattened below and quite strongly convex above, with two prominent raised surfaces on the second and third thoracic segments. Its color is still reddish brown, with several darker spots, especially upon the front half and along the sides of the posterior half of the body, and the antennæ and legs are black. The antennæ are now eleven-jointed instead of nine; joint one is nearly twice as wide as long; joints two and three are subequal in length and thickness, and are each somewhat longer than broad; joint four is a little more than half as long as three, and is narrower; joints five, six, seven, eight, nine, and ten increase gradually and slightly in length, and decrease very slightly in width; joint eleven (club) is irregularly ovoid, and is one and a half times as long as ten; the special hairs are a little shorter than in the previous stage. The whole body is furnished with short, black hairs, more numerous than in the last stage, arranged in tufts, particularly around the edge, where they occur in a double parallel row, the inner row being practically subdorsal and accentuated by a slight ridge. Down the central portion of the dorsum of the abdomen the segments are indicated by the transverse rows of hair tufts. The secretory pores are

exceedingly abundant, occurring in enormous numbers just under the lateral edges of the body, and scattered more sparsely over the back. The individual wax filaments which issue from these pores are very delicate and curly, and there is reason to suppose that two or three issue at one time from one pore, as they are frequently seen connected at base; the pore opening, however, seems to have a single simple opening. The inner row of tufts on the back is broken at its anal point by a depression, in which is situated a very large pore, from which the insect occasionally ejects a globule of a semi-liquid honey-dew. This depression is surrounded by an irregular ring of hairs, which are yellowish in color instead of black. The glassy filaments arising from the large tubular pores described in the last stage are now very long, and radiate from the body in almost every direction. They break off easily, yet still often reach a length double that of the insect and her egg-sac together. What is probably the opening of the oviduct is situated on the under side of the seventh abdominal segment. It is surrounded by a transversely oval chitinous ring.

The Egg-Sac.—As the body of the female begins to swell from the eggs forming inside, the beginning of the egg-sac is made. The female lies flat on the bark, the edges of the body turned slightly upward, and the waxy material of which the sac is composed begins to issue from countless pores on the under side of the body, but more especially along the sides below. As the secretion advances the body is raised, the cephalic end being still attached, until, near the completion of the sac, the insect is, apparently, standing on its head, nearly at right angles to the surface to which it is attached. The egg-laying commences as soon as a thin layer of the secretion has formed on the under side of the abdomen, and it continues during the formation of the sac. There soon appears around the edge of the abdomen a narrow ring of white felt-like wax, which is divided into a number of flutings. These flutings grow in length, and the mass of eggs and wax under them increases, forcing the female upward until the sac is completed. When completed, it is from two to two and one half times the length of the female's body. It is of snow white color, and the outside is covered with fifteen of these longitudinal ridges, or flutings, of subequal size, except that the middle one is smaller than the others. The upper part of the sac is firm in texture, but the lower is looser and thinner, and from the middle of the under side the young make their escape soon after hatching. The size of the sac and the length of time required in its growth depends, leaving the weather and the health of the food-plant out of consideration, upon the number of eggs which the female deposits. So long as oviposition continues, the secretion of wax accompanies it, and the egg mass grows. Concerning the rate of growth, Mr. Coquillett gives the following instance:

"On the fourth of May of the present season I marked a large number of females which were located upon the trunk of an orange tree that was not in a very healthy condition. These females had just begun to secrete the cottony matter, the latter at this date being in the form of short but broad tufts around the margin of the abdomen, those at the hind end of the latter being longest. By the thirty-first of May the cottony matter was equal in length to one third of the female's body, and by the middle of July it about equaled in length the entire body of the female. As the egg-masses of some of the females upon the same tree were longer by one half than the bodies of the females which produced them, it is very probable that at least another month must elapse before the egg-masses of the females which I observed would be completed. It is altogether likely, however, that these egg-masses would have been completed in a shorter time had the females been located upon a healthy tree. The egg-masses found upon healthy trees attain larger size than those found upon sickly trees, owing, doubtless, to the fact that the females living upon trees of the former kind are more vigorous than those upon unhealthy trees."

The Male Larva—Probable Second Stage.—Neither Mr. Coquillett nor Mr. Koebele were able to distinguish the male larvæ until these had reached the stage in which they form their cocoons. Among the specimens studied at the Department, and which were sent alive from Los Angeles by Mr. Koebele, we have found a larval form which has not yet been described, and which we strongly suspect may be the male in the second stage. This form is illustrated at Figure 18. It differs from our supposed second stage of the female in its more slender form, longer and stouter legs, and longer and stouter antennæ. The legs and antennæ are not only relatively longer and stouter, but are absolutely so. The body above is much more thickly clothed with the short stout hairs than the corresponding female stage, and the mentum is longer and darker colored. The antennæ are six-jointed, and the joints have precisely the same strange relative proportions as in the female. The secretory pores are present, but not quite so numerous as in the female.

Male Larva—Third Stage.—In this, the third or last larval stage, the male is readily distinguished with the naked eye from the female in any stage by the narrower, more elongate, more flattened, and evenly convex form of his body, as well as by his greater activity in crawling about the trunk or branches of a tree. More careful examination shows that the beak is entirely wanting, the tubercle from which it arises in the earlier stages being replaced by a shallow triangular depression. The body is almost naked, being very sparsely covered with a short, white, cottony matter, and is destitute of the short but stout black hairs which are found upon the body of the female during the third and fourth stages of her life. In the absence of black spots and in the nine-jointed antennæ, he agrees with the similar or third stage of the female, and the average length when full grown is about 3 mm. and diameter about 1 mm.

The Male Pupa and Cocoon.—When the male larva has reached full growth and is ready to transform, it wanders about in search of a place of concealment, finally secreting itself under a bit of projecting bark, under some leaves in the crotch of a tree, or even wedg-

ing itself down under a mass of females. Very frequently, probably in the majority of cases, it descends to the ground and hides under a clod of earth, or works its way into some crack in the ground. Having concealed itself, it becomes quiescent, and the delicate, flossy substance of which the cocoon is formed begins to exude abundantly from the body. This material is waxy in its character, but is lighter and more flossy, and less adhesive than that of which the egg-sac of the female is composed. After a certain amount has been exuded, the larva moves backward very slowly, the exudation continuing until the mass is from 7 mm. to 10 mm. in length. From this method of retrogression it happens that the body of the larva is frequently seen protruding posteriorly from the mass, which naturally leads to the erroneous conclusion that the material is secreted more abundantly from the fore part of the body, whereas the reverse is the case. When the mass has reached the proper length the larva casts its skin, which remains in the hind end of the cocoon, and pushes itself forward into the middle of the cocoon.

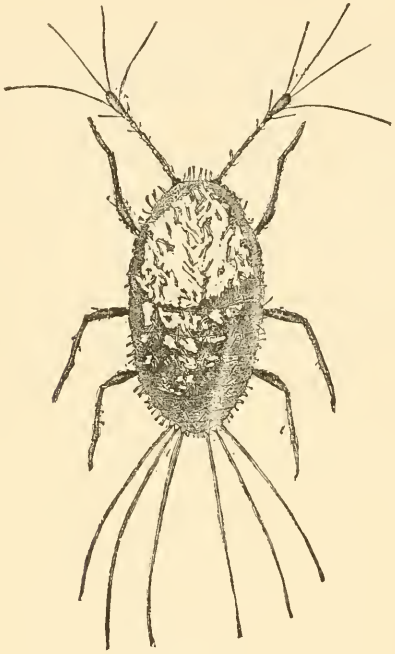

Figure No. 18.

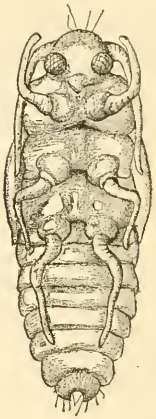

Figure No. 19.

The pupa (Figure 19) has the same general color as the larva, the antennæ, legs, and wing-pads being paler and the eyes dark. It has also the same general form and size. All the members are free and slightly movable, so that they vary in position, though ordinarily the antennæ are pressed close to the side, reaching to basal part of metathorax (ventrally); the wing-pads also against the side, elongate-ovate in form and reaching the second abdominal joint. The legs are rather shorter than the diameter of the body, and the front pair thrust forward. The anal end is deeply excavated, the abdominal joints well separated, the mesonotum well developed, and the pronotum tuberculous are with some eight prominences; but there are no other structural peculiarities. The surface is, however, more or less thickly covered with waxy filaments, which are sometimes exuded in sufficient quantities to give quite a mealy appearance.

Whenever the pupæ are taken from the cocoon and placed naked in a tin box, they exude a certain amount of wax, often enough to partially hide them from view. If disturbed, they twist and bend their bodies quite vigorously.

The cocoon is of an irregular, elongate shape, appearing a little denser in the center where the pupa has placed itself, and at the edges delicate and translucent. The material of which the cocoon is composed is very delicate, and appears like the finest cotton, but on submission to a gentle heat it melts as readily as the coarser secretion of the female, and leaves the larva or pupa, as the case may be, clean and exposed.

The Adult Male (Figure 20).—The following detailed description is drawn up from numerous specimens both mounted and living:

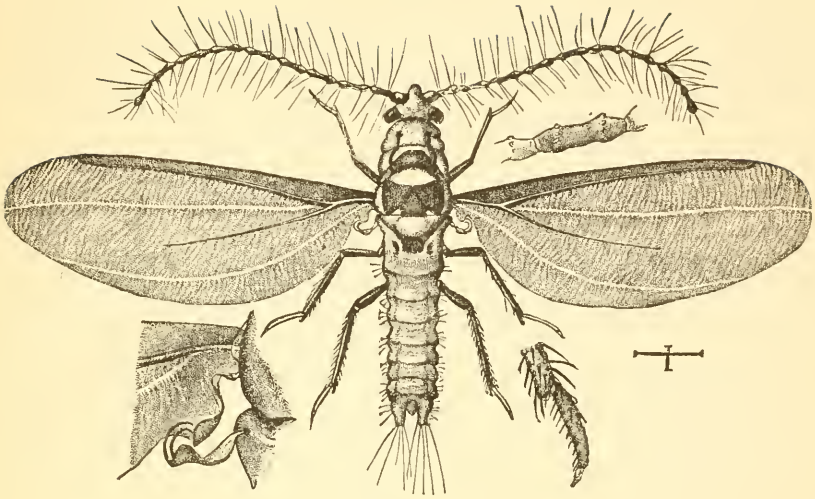

Figure No. 20.

"The adult male is a trifle over 3 mm. in length, and has an average wing expanse of 7.5 mm. The general color is orange red. The head above is triangular in shape, with the apex blunt and projecting forward between the bases of the antennæ. The eyes are placed at the other apices of the triangle, and are large, prominent, and furnished with well marked facets. There are no mouth parts, but on the under side of the head is a stellate black spot with five prongs, one projecting forward on the conical lengthening of the head, one on each side to a point just anterior to the eyes and just posterior to the bases of the antennæ, and the remaining two extending laterally backward behind the eyes. The antennæ are light brown in color, and are composed of ten joints. Joint one is stout, almost globular, and nearly as broad as long; joint two is half as broad as one, and is somewhat longer; joint three is nearly twice as long as one, and slightly narrower than two; joints four, five, six, seven, eight, nine, and ten are all of about the same length as joint three, and grow successively a little more slender; each joint, except joint one, is furnished with two whorls of long light-brown hairs, one near base and the other near tip; each joint is somewhat constricted between its two whorls, joint two less so than the others. There are no visible ocelli. The pronotum has two wavy subdorsal longitudinal black lines, and the mesonotum is nearly all black, except an oval patch on the scutum. The metanotal spiracles are black, and there is a transverse crescent-shaped black mark, with a short median backward prolongation. The mesosternum is black. The legs are also nearly black and quite thickly furnished with short hairs. The wings are smoky black, and are covered with rounded wavy elevations, making a reticulate surface, a cross section of which would appear crenulate. The costa is thick and brown above the subcostal vein, which reaches costa at a trifle more than four fifths the length of the wing. The only other vein (the median) is given off at about one sixth the length of the wing, and extends out into the disk a little more than one half the wing length. There are, in addition, two white lines, one extending out from the fork of the subcostal and the median nearly straight to the tip of the wing, and one from the base in a gradual curve to a point some distance below the tip. Near the base of the wing below is a small ear-shaped prolongation, folded slightly on itself, making a sort of pocket. The halteres are foliate, and furnished at tips with two hooks, which fit into the folded projection at base of wings. The abdomen is slightly hairy, with the joints well marked, and is furnished at tip with two strong projections, each of which bears at tip four long hairs and a few shorter ones. When the insect is at rest the wings lie flat upon the back."

Rate of Growth of the Different Stages.

The rate of growth of the insect necessarily depends so much upon surrounding conditions, and especially on the mean temperature, that it is difficult to make any definite statements as to time elapsing between molts or that required for other periods of the insect's growth. No facts have hitherto been published which bear upon this point. Mr. Coquillett's observations show that individuals hatched from eggs on the fourth of March cast the first skin on the twenty-third of April, and underwent the last molt on the twenty-third of May.—Mr. Koebele also reports a case which bears upon this point, and which is interesting as occurring later in the season. He placed four newly hatched larvæ on a healthy young orange tree, out of doors, August fifth. On September twenty-sixth two of them passed through the first molt. October tenth one more molted, and on October

twenty-third the fourth cast its first skin. All left the leaves after molting and settled on young twigs. None of them had gone through the last molt when he left Los Angeles, November sixth. He was afterwards informed by Mr. Alexander Craw, of Los Angeles, that nearly all of the insects were full grown in February, and he therefore concluded that the individuals observed by him would not attain full growth before that time.

The mature male larva requires on an average about ten days from the time it begins to form the cocoon before assuming the pupa state, and the pupa state lasts from two to three weeks. The more reliable information we have been able to obtain would show that at Los Angeles the average number of generations each year is three.

HABITS.

The fluted scale infests chiefly evergreen trees and seems to have an especial liking for Australian plants, notably the acacia tribe, which on account of this insect, in many sections of the State, has been replaced by other trees. Of fruit trees, the orange family is especially subject to its attacks, and its ravages in this country, as well as in South Africa, have been very severe. But although there exist many plants which are but little affected by this scale, there are scarcely any on which it may not find lodgment for some time until a better suited subject is found. Falling to the ground they will exist on weeds and grass for some time, on some, such as nettles, thriving most wonderfully. It is this habit that has made this insect the most difficult to exterminate when well established.

NATURAL ENEMIES OF ICERYA PURCHASI.

It is a singular fact that after an existence of some twenty years in this State, but few natural enemies have shown themselves. Under the head of "Beneficial Insects," I have recorded the *Scymnus marginicollis* as eating the eggs. In Professor Riley's report of 1886 I find the following underlines on this point:

Neither Mr. Coquillett nor Mr. Koebele (his agents in California) have observed any birds feeding on the icerya.

The only predaceous insects recorded by Mr. Coquillett to feed on it was the larva of a species of chrysopa, or lace winged fly. The ambiguous ladybug has been known to feed on the eggs when they were exposed to view.

Among predaceous insects recorded by Mr. Koebele, and sent to me, is the larva of a small moth, which was found feeding on the dead larvæ; if they could live on the living scale I had no proof.

Two beetles, *Blastinus* and *Perimegatoma*, were found among dead larvæ; it is considered doubtful if they destroy living ones.

The most efficient destroyer of the cottony cushion scale, at Los Angeles, is perhaps a species of earwig, family *Forficulidæ*, neither the genus nor species of which we are able to determine, from the fact that we have only seen immature specimens. According to Mr. Koebele, this insect is often met with among the scales, and, from observations which he made, feeds greedily upon the icerya in all the stages, tearing open the egg-masses and eating the eggs, and also tearing and eating the mature insects, as well as the larvæ. The breeding habits of the mother earwig and her care of her flock of young have been observed by Mr. Koebele, but have been so well studied by European authors as to need no detail here.

Mr. Koebele also reports the occurrence in the scale masses, in large numbers, of a minute whitish mite, which becomes of a reddish color when full fed, and which he thinks destroys the female scales. We have not seen specimens of this mite, and are therefore unable to determine it.

Parasites.—It is a somewhat remarkable fact that no true parasites were ever bred from the cottony cushion scale until the past summer, and still more remarkable that in the course of their careful investigations, extending over a space of six months, neither Mr. Coquillet nor Mr. Koebele succeeded in finding a single parasite upon this insect. From a number of scales, however, sent to Washington by Mr. Koebele November tenth, we bred, on December eighth, two specimens of a small chalcid, which is, without question, a

true parasite of icerya, as the female scales from which they escaped were found each with a small round hole in its back.

This little parasite is prettily marked with black and yellow. It is new to our fauna, and may have been imported with its host. I turned it over to Mr. Howard for study, and, as he finds it necessary to erect a new genus for it, I append his generic and specific characterizations:

Isodromus n. g., Howard.

Female.—The antennæ arise near the border of the mouth; the scape is not widened; *the pedicel is much longer than the first funicle joint;* the funicle joints increase slightly in length from one to six and considerably in width, so that joint six is more than twice as wide as joint one; the club is half as long as the funicle and is obliquely truncate from base to tip. The head is thin antero-posteriorly; the facial impression is slight; *the inner borders of the eyes are nearly parallel;* the ocelli are placed at the corners of a right-angled triangle. The scalpulæ meet on a long line at middle. The hind femora have a very delicate longitudinal furrow below. The marginal vein of the fore wings is entirely wanting; the stigmal is moderately long and *bends abruptly downward, forming at first a right angle with the submarginal,* afterwards curving slightly outwards; *the postmarginal is absent. The large mesopleura are covered with a number of longitudinal ridges.*

Male unknown.

In Other Countries.—In Miss Ormerod's treatise on the icerya is found an account of a new species of lady-bug sent her by a correspondent in South Africa, Mr. S. Bairstow, of Port Elizabeth. This species resembles our chilecorus in markings, being a bluish black, with two red spots, but is hairy; it has been named *Rodolia iceryæ*. Mr. Bairstow also sends a species of lace-wing fly, the larva of which he has found in large numbers. In a letter received in December last from Mr. Bairstow by myself, he says: "Without doubt in this province last season rodolia and chrysopa worked miracles, which, though the human eye may not discover accurately after effect, reason may safely promise beneficial results." Mr. Bairstow in his letter promised to send me specimens of these insects at the first opportunity.

At the Santa Barbara Convention I read a small paper on the question of bringing parasites here, and the letters from Mr. Bairstow and Mr. F. S. Crawford, of Adelaide, Australia, were published in full, to which the reader is referred. The second small consignment arrived here in June, they having been sent in the ice chest on the steamer "Zealandia" in special care of the purser. A large wire cage was made so as to inclose a bush four feet high. Here the infested bugs, a species of monophlebus*, were tied in a cloth to a branch of the tree—an English laurel. At the time of opening the box some of the flies had hatched, but were all dead. A visit three weeks after showed that no more had appeared. About two months after, however, I again visited the place and found, judging from the holes in the bugs (monophlebus), that from fifty to sixty flies had escaped.

So far, therefore, the experiment, I believe, will prove a success if the parasite is as well adapted to live on the icerya as on the monophlebus. It is, of course, yet too early to know if any progeny has been left by these flies.

That there exists a very important agency in Australia that keeps the icerya in check, letters received by Professor Riley from various people, and especially those lately received by myself from Mr. Crawford, go to prove. If this insect is the chief one, is now to be investigated by Mr. A. Koebele, who through Professor Riley's influence has been sent there.

An insect on which so much hope is based will naturally be of interest, and I publish in full its description.

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* *Monophlebus crawfordii* (Maskell), a coccid found living on certain eucalyptus in South Australia.

The following description of the genus and species to which this interesting parasite belongs is taken from "Insect Life."* It was written by Dr. Williston for Professor Riley. The cut has been procured through the courtesy of the last named gentleman:

Lestophonus, new genus.

Front, broad plane, with scarcely distinguishable hairs in upper part; antenna large, the first two joints short; the third two or three times as long as broad, reaching quite to the oval margin; arista wanting; face flattened, or gently concave; thorax without bristles; scutellum large, about half as long as the thorax, convex; abdomen short, ovate, rather broad, composed of five segments; thinly and bristly hairy; legs rather short and strong; middle tibiæ, with a minute and indistinct spur at the top; all the tibiæ without erect bristles on the outer side before the tip; wings short and broad; auxiliary vein wholly wanting; first longitudinal vein first terminating at the basal third, the costal vein at the tip of the third longitudinal; second and third longitudinal veins nearly parallel; the fourth vein gently divergent; penultimate section of the fourth vein, a little shorter than the ultimate section of the fifth; second basal cell and the discal cell united; anal cell distinct.

Notwithstanding the presence of the anal cell, the present species must, I believe, be located with the oscinidæ. The absence of distinct bristles on the front, or, indeed, elsewhere on the body, will prevent its location with drosophilinæ. In all the four specimens that I have examined, the arista seems entirely wanting. I cannot attribute its absence to injury. This remarkable character, together with the absence of the anterior basal cross vein and auxiliary vein, and the very large third antennal joint, will, I believe, render the genus easily recognizable. I can find the description of no genus that will apply, and I have but little or no hesitancy in describing it as new. Modillus, from Europe and Africa, seems to be its nearest relative.

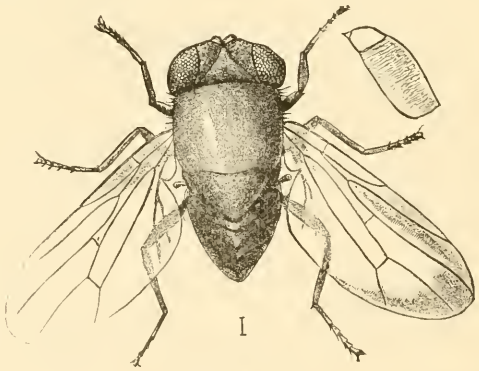


Figure No. 21.

Lestophonus icerya, new species.

Female, 1.1 mm.; face, front; dorsum of thorax and scutellum deep blue, moderately shining; antenna, black oblong, with rounded ends; abdomen punctulate, deep shining green, in some specimens more or less blue; legs dark brown, or blackish brown; front tarsi more lutescent, or brownish yellow; veins grayish hyaline, the veins dark brown.

REMEDIES.

There is no species of insects existing in this State on which so many different remedies have been tried, and some of the simplest have proved the best.

Caustic solutions have the disadvantage of hurting the tree, and are not especially adapted to penetrate into the egg-sac, which on account of its peculiar texture repels most liquids.

Various soap solutions, some containing kerosene and some whale oil, have proved fair remedies, but can in my opinion not be equaled by the

*"Insect Life" is a periodical published under the direction of the United States Entomologist, Professor C. V. Riley.

rosin solutions of which we give three formulas. The first was first tried by Mr. A. Koebele; the second by Mr. Alexander Craw, of Los Angeles; the third has been given me by Mr. L. D. Green, of Sacramento. From personal experiments with them all I am well satisfied with them.

Recipe No. 1.—Four pounds of rosin, three pounds of sal soda, water to make thirty-six pints. Dissolve the sal soda in a few pints of water; when thoroughly dissolved add the rosin. Heat until dissolved, and add water finally. Use two quarts of solution to the gallon of water. Use at a temperature of about 100 degrees Fahrenheit.

Recipe No. 2.—One pound of caustic soda, ten pounds of rosin, one hundred gallons of water. Prepare as above.

As, perhaps, owing to the nature of the caustic, the leaves are sometimes liable to be affected, I should recommend the spraying of the trees with pure water liberally (the water will free the pores of the leaves), then two or three days after the applications of the rosin solutions.

These solutions being cheap they may be used liberally, and two or three treatments a year would, I think, keep the trees in fair order.

Recipe No. 3.—Sixty pounds of rosin, sixty pounds of tallow, ten pounds of potash, dissolved in ten gallons of water; ten pounds of caustic soda (Greenbank, 98 per cent). Dissolve the rosin and tallow; when dissolved add caustic water slowly. After mixture is made, add ten gallons of water. Use at the rate of one gallon of mixture to ten gallons of water.

In the case of the black scale I have found the addition of sulphide of soda at the rate of one gallon to seventy-five of rosin solution, the strength of sulphide being one pound of concentrated lye to two pounds of sulphide, beneficial, and I should recommend the trial of this for icerya. In several orchards in Santa Barbara cold water has been sprayed on the trees with great power, but while it must be considered superior to many of the injurious ingredients used, it is only by its constant application that trees can be kept clean.

Banding of the Trunks.

A most essential help in checking the icerya's spreading, whatever method of cleaning is used, is the placing of bands on the trunks of the trees—say six inches from the ground—which are usually strips of sheepskin, the hairy side turned in and the smooth side out. The bands should be drawn as tight as possible, and the outside covered with a mixture of molasses, or printers' ink, or any substance that will remain sticky for some time. The minute scale, which are constantly traveling through the summer time, will be either caught in the sticky solution or find lodgment in the wood. From time to time the bands must be taken off and dipped in scalding water, and carefully replaced. The portion of the trunk below should be washed with a strong rosin solution, three times as strong as any recommended above.

Gas Remedies.

In my last report to the State Board of Horticulture was given an account of the various experiments made by different parties. In the recently published report of Professor Riley, "United States Entomologist," Mr. Coquillett, of Los Angeles, gives an exhaustive account of experiments with various gases, but I am of the opinion that none will supersede the hydrocyanic gas, first used by Messrs. Craw, Wolfskill, and Coquillett, and later discovered and recommended by F. W. Morse, of the University of California.

The opinion then expressed, that no doubt applied, which would make the application of the hydrocyanic gas void of danger, and cheapen the process on the whole, I am glad to say, has been fulfilled, although my

sanguine expectation that all eggs could be killed has failed. While it may be done, and has been done, so many intervening causes, especially the difficulty of keeping a tent gas tight, in a treatment of an orchard, I dare say the only practical way of exterminating the insect will be by two treatments—say four weeks apart. The first treatment would exterminate large bugs, everything not in the egg state, and the majority of the eggs. The second, the remainder—all eggs then being hatched.

Modes of Treatment.

In Bulletin No. 73 Mr. Morse gives full directions for using the gas. To avoid the injury to the foliage, which, according to the later investigations of Mr. Morse, is due to free ammonia gas, Mr. Morse employed carbonic acid gas, which was generated simultaneously by pouring the mixture of cyanide and carbonate solution together in the receiver.

The Process.

I copy the following from Bulletin of Experimental Station, of Berkeley, No. 73:

Solutions.—The cyanide of potassium solution (*not* the "mining cyanide") is prepared by dissolving the salt in the proportion of ten pounds to two gallons of water. Place the cyanide in the vessel in which you wish to make the solution, and add the water to it, bring to nearly boiling, with occasionally stirring, and let it cool. It is best to make the solution one or two days before using, in order to avoid as much as possible the stronger odor of a freshly prepared solution.

In the prescribed dose an excess of acid has been recommended, in order that complete action shall always take place. It is desirable to test the residue occasionally, to be satisfied that the work is complete. This is done by adding a little more acid, and noting whether boiling or effervescence takes place upon stirring; care being taken not to mistake the effervescence from the material accidentally gathered on the sides of the cylinder during the operation for that of material which should have been acted upon in the bottom of the cylinder.

Doses According to Size of Trees.

The regulation of the doses for the different sized trees, so as to produce uniform treatment, is calculated on the basis of the results of the experiments which determined the amount of each constituent for a twelve-foot tree. The following table indicates the amounts of trees of different dimensions of top, based upon the rates of cubical contents.

The amount of material for each dose differs from that previously recommended (Bulletin 71), by a decrease of one fourth in the amount of soda, and a slight change in the acid; the cyanide remains the same. Varying amounts of soda were used, showing quite clearly that a decrease of one fourth was possible, but further than this an appreciable lessening in the preservative effect was noticeable.

Size of Tree.	Cyanide of Potassium—Fluid Ounces.	Bicarbonate of Soda—Pounds.	Sulphuric Acid—Fluid Ounces.
Five feet	1.6	.1	.9
Six feet	2.5	.2	1.6
Seven feet	4.0	.3	2.6
Eight feet	6.0	.4	3.8
Nine feet	8.5	.5	5.5
Ten feet	11.5	.7	7.5
Eleven feet	15.5	.9	9.9
Twelve feet	20.0	1.1	12.9
Thirteen feet	25.4	1.5	16.5
Fourteen feet	31.6	1.9	20.5
Fifteen feet	39.2	2.2	25.3
Sixteen feet	47.5	2.6	30.7
Seventeen feet	57.5	3.1	37.8
Eighteen feet	67.7	3.8	43.7
Nineteen feet	70.9	4.4	51.3
Twenty feet	90.5	5.2	60.0

The prescribed doses for small trees will be found too small, unless the trees are very low. The calculations are all based upon the supposition that the trees are nearly spherical in shape; but in most cases it will be found that the trees of small dimensions have most of the branches raised fully four or five feet from the ground, thus leaving a large volume on the inside of the tent unoccupied. Due allowance must be made when the height of the tree is so much greater than its diameter.

Mode of Operating.

Place the desired amount of acid in the acid receiver, then put the required amount of soda in a convenient vessel (a gallon measure serves the purpose well), and add water to bring it to a thin paste, stirring well to get rid of all the lumps, before the cyanide solution is added. Mix the cyanide solution and the soda paste so that the undissolved soda will remain evenly distributed throughout the mixture. Pour into the cyanide receiver, and allow it to run slowly and *regularly* upon the acid which has previously been run into the generator. As soon as the cyanide solution begins to enter the generator, the blower should be turned slowly, and continued until all the material is run in and violent action ceased. This usually takes a minute or so after the materials have united. Then follow with violent blowing for a minute or so, and allow to rest until about fifteen minutes from the beginning of the treatment, when violent blowing is repeated for one minute. The time occupied in running in the mixture should be about as follows for the different sized trees:

10-foot tree	4 minutes.
11-foot tree	5 minutes.
12-foot tree	5.5 minutes.
13-foot tree	6 minutes.
14-foot tree	7 minutes.
15-foot tree	7.5 minutes.
16-foot tree	8 minutes.
17-foot tree	9 minutes.
18-foot tree	10 minutes.

It is quite important that the *time of injecting shall be closely observed*, and should be lengthened rather than shortened. No time will be saved by hurrying this part of the treatment, for if run in too fast lumps will be formed which will take some time to be completely acted upon by the acid. If the time is slightly lengthened no serious results will follow. Some of the largest doses have been completely acted upon in less than fifteen minutes, thus making it possible for a single generator to serve two tents when the prescribed time of exposure is adopted. It is advisable to continue the treatment of a single tree for about thirty minutes, although the time may be slightly shortened when two tents are used.

This method can be used when the temperature does not rise much above 70 degrees F., but when it becomes much higher it will affect the foliage. To avoid this trouble it is suggested to do the work during the cooler portion of the year.

Dry Gas Process.

In Mr. Coquillett's report to Professor Riley in reviewing the different processes is favored the method of passing the gas through sulphuric acid, which method he describes as follows, under the name of *the dry gas*, his idea being that the damage done by hydrocyanic gas, when generated, is due to moisture which carries particles with it:

I have already alluded above to the fact that the drier the gas the less injurious was the effect upon the tree confined in it; and it occurred to me that the gas might be generated in the usual way, by acting with sulphuric acid upon potassium cyanide dissolved in water, and afterward be dried by passing it through some medium that would deprive it of its moisture. Knowing the great avidity of sulphuric acid for moisture, I determined to use it as a drier for gas, and several tests which I have made with this gas dried in this way prove that it does not injure the foliage of orange trees confined in it, while it is just as fatal to the scale insects as is the moist gas. The density of the acid through which the gas had passed was lowered about one degree, as indicated by the hydrometer; but this would not prevent its use for generating the gas.

The cyanide is dissolved by boiling in water for a few minutes, using one gallon of water for each five pounds of cyanide. It is desirable to use as little water as possible for this purpose, but the quantity could not be very much reduced from that given above. I have tried to dissolve five pounds of the cyanide in half a gallon of water, but all of the cyanide had not dissolved after half an hour's boiling. For every ounce of the cyanide solution use half an ounce of sulphuric acid, but it is always desirable to add some of the acid to the prescribed dose, in order that there may be an excess of the acid. No evil results will follow if double the proper quantity of the acid were to be used, whereas if less

than the proper quantity were used the whole of the gas would not be evolved from the cyanide solution; hence the advisability of always using an excess of the acid.

In generating the gas the acid should flow upon the cyanide solution in a very fine stream. When they come in contact violent action at once takes place, and the gas is rapidly given off in the form of dense whitish fog, resembling smoke and possessing a peculiar odor. When this gas, diluted with air, is inhaled, it produces a dryness in the mouth and throat.

It is impossible to give any definite rule for using the different ingredients that will apply to the differently sized trees, owing to the fact that trees of the same height may have a varying diameter of top; thus orange trees twelve feet tall may have a diameter of top ranging all the way from six to ten feet. The manner in which the tree is pruned will also make a difference in the quantity of the ingredients to be used, some trees being allowed to branch almost from the ground, while others are trimmed up from three to five feet from the ground.

The following table based upon numerous experiments which I have made on orange trees under a tent ten feet tall and having a transverse diameter of ten feet, will give a good idea of the proper quantities of each ingredient to be used in treating citrus trees:

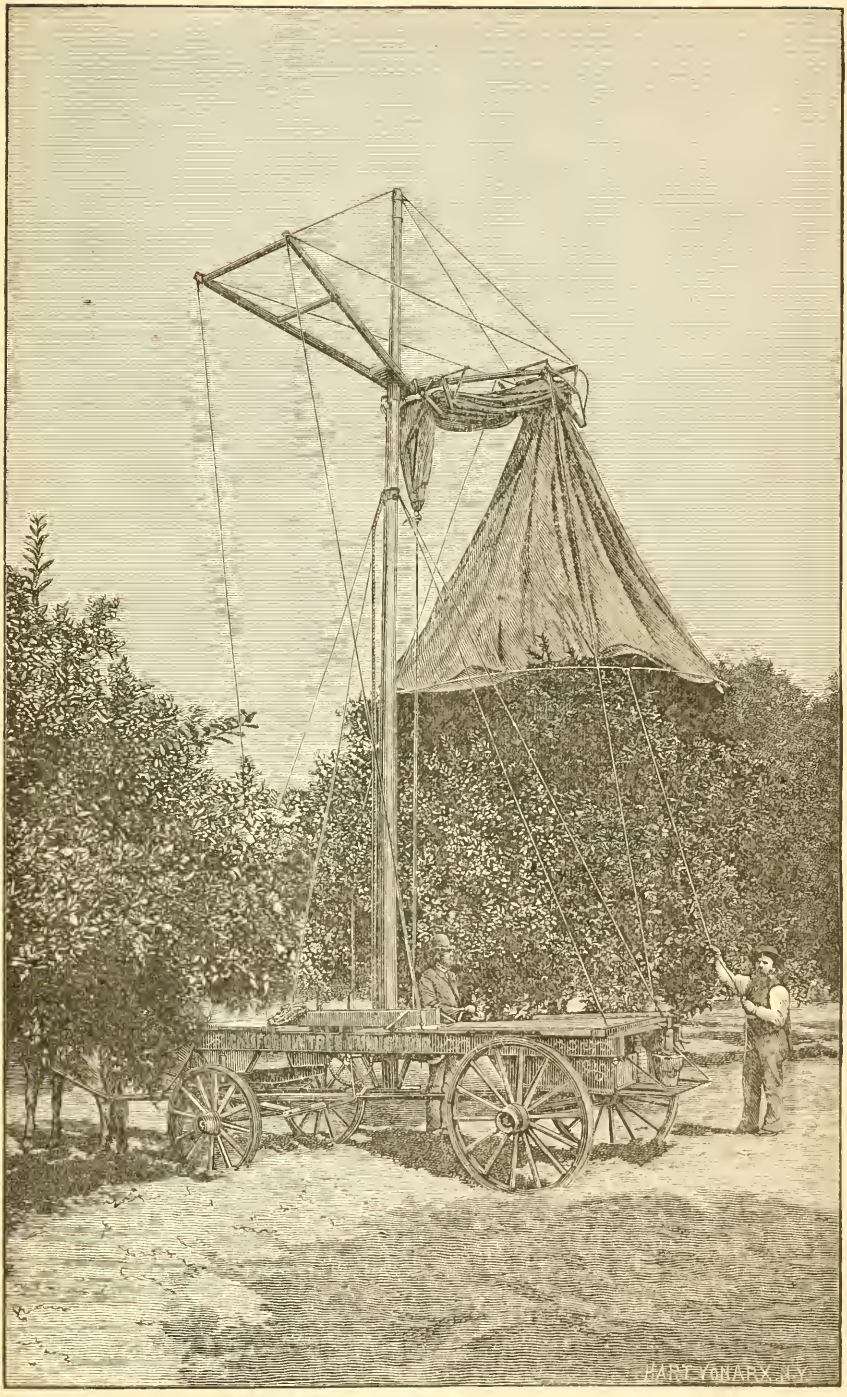
Height—in Feet.	Diameter—in Feet.	Cyanide Solution—Fluid Ounces.	Sulphuric Acid—Fluid Ounces.
6	5	2	1¼
10	10	12	7
12	8	9	5
16	12	28	16
20	14	47	26

This table is based upon the cubical contents of the space inclosed by the tent, supposing that the lower part of the tent rests upon the ground. No harm will result to the tree if twice the quantity that I have recommended be used; but of course, for the sake of economy, it will be desirable to use only such quantity of each ingredient as will be necessary for destroying the scale insects infesting the tree to be treated with this gas. The sulphuric acid should have a density of 65 degrees when tested with an acid hydrometer; should its density be lower than this, use an extra ounce of the acid for every 5 degrees of density below 65 degrees.

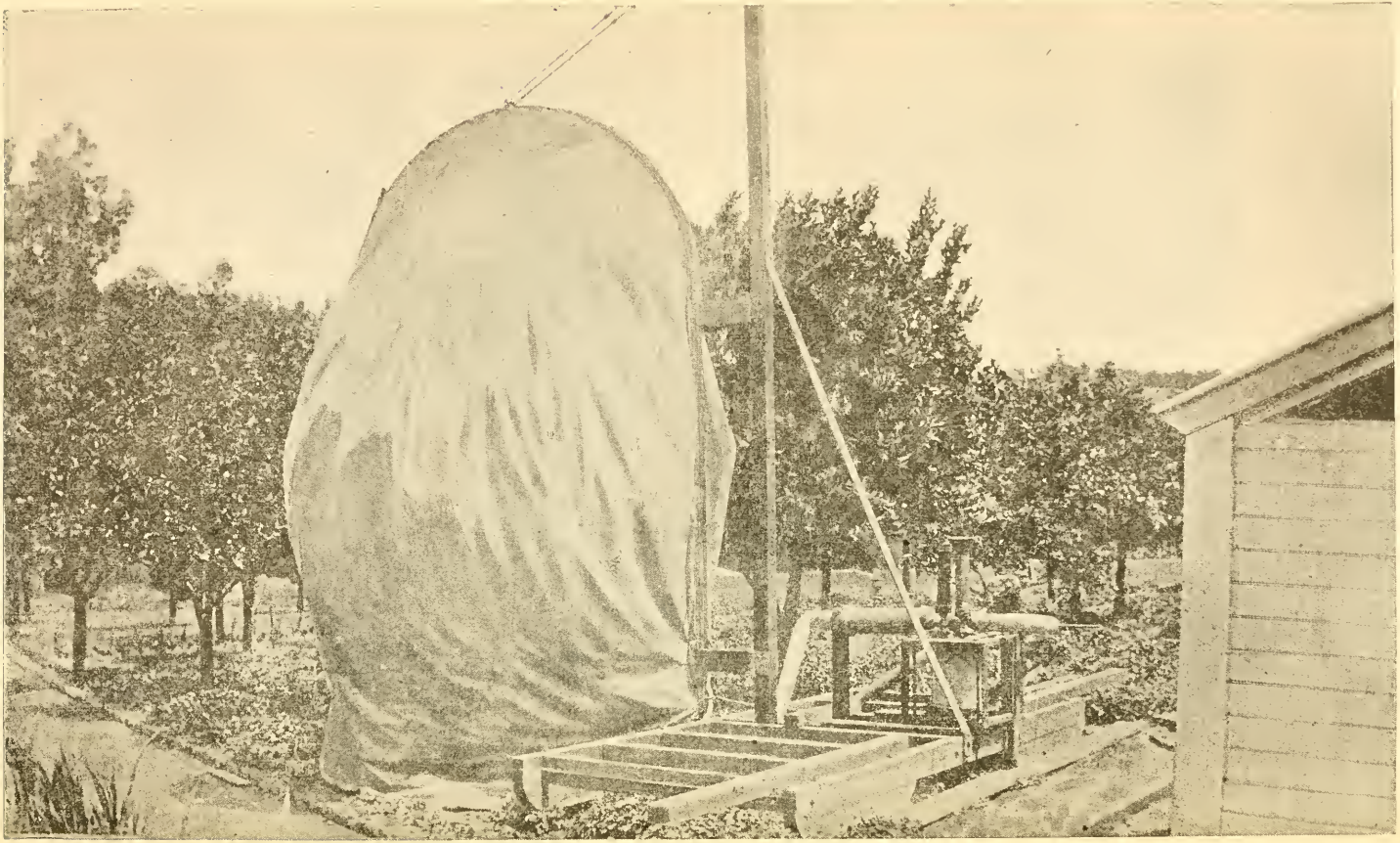
According to Mr. Morse's experiments, however, it has been proved that the injury to foliage was caused by ammonia, which, especially through the direct influence of sunshine, is evolved from the gas confined in the tent, and Mr. Morse suggests, therefore, instead of passing the gas through liquid sulphuric acid, to construct a drier large enough to have it filled with a quantity of pumice stone saturated with sulphuric acid. To test this idea on a larger scale, and to also test the practical workings of the Culver tent, I obtained the consent of the Commission to have an apparatus made. From Mr. J. P. Culver, of Los Angeles, I obtained permission to make use of his drawings and plans, and had a tent constructed according to his idea, with slight modifications except to size of timbers, frame, etc., which were reduced one half, fully, making the whole apparatus so that it could be drawn along on level ground by one horse. The frame and sled on which the tent rests are five and a half by twelve feet, and are made of Oregon pine with runners of oak.

The tent proper consists of two even halves swung on heavy hinges fastened to the mast, and the frame on which the cloth is fastened is made of two by two-inch ash. The curved part of the frame or arch is made of one by two-inch, lapping and bolted together. Where the two frames meet to close the tent a strip of heavy felting is nailed on it. The tent cloth is made of heavy, fine-woven drill, oiled with linseed oil, and is tacked on the edge of the frame. The mast on which the heavy iron hinges are fastened is made of a four by four, but it would be advisable to have this a little heavier or have it banded with iron. On the top two iron rods, with thumb-screws and thread in the middle, are held in iron hooks. These rods are an essential support for the two wings of the tent when they are swung on the hinges. When a tree is to be treated the frame is drawn

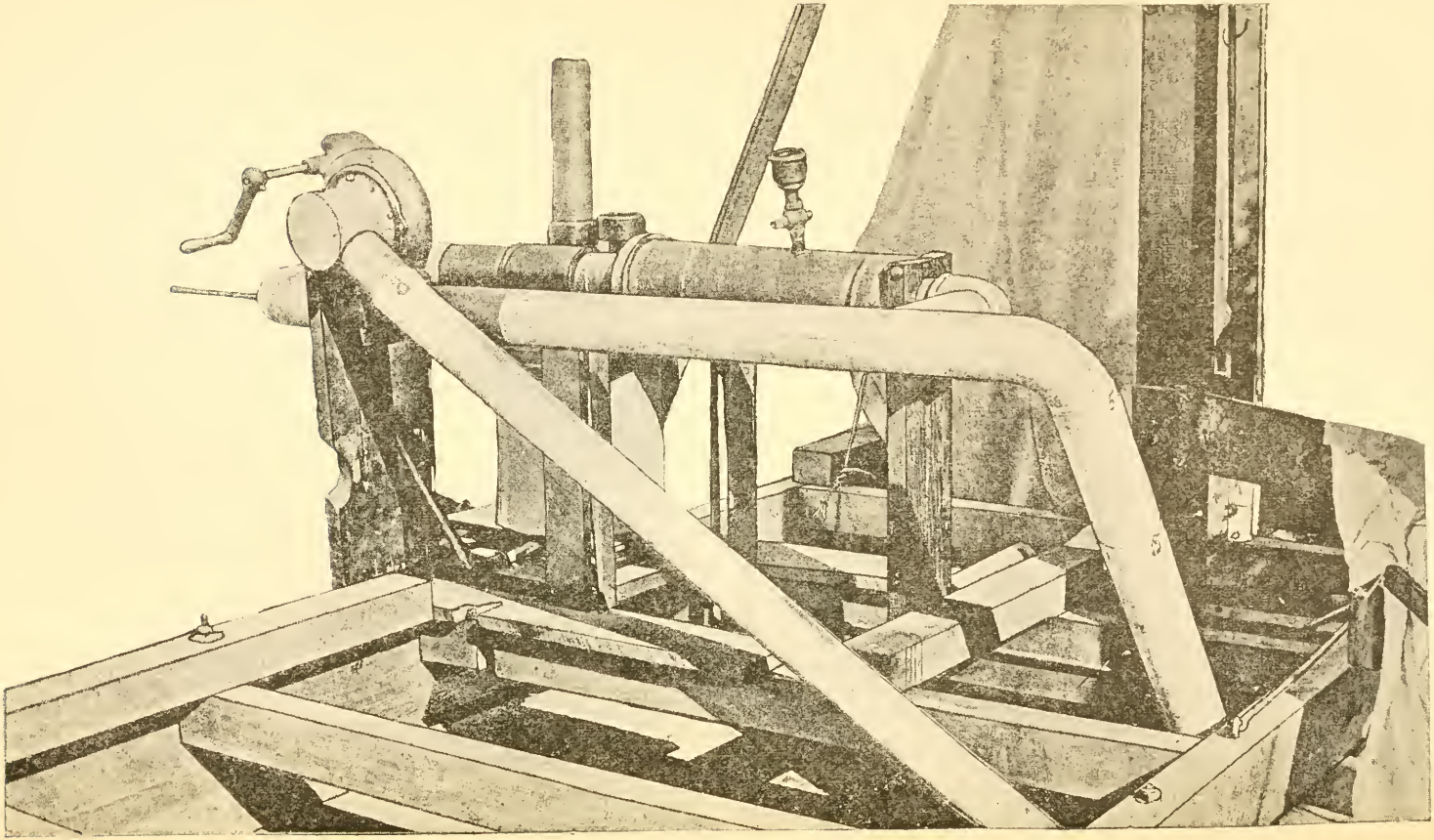
Titus Fumigating Apparatus.



Wolfskill Fumigating Apparatus.



Culver Fumigating Apparatus and Morse Generator.



Morse Generator.

closely up to the tree, the mast on line with center of the tree, and the wings are closed. The parts are kept tight together by means of a rope passing through screw-eyes placed alternately on both frames, thus lacing them together after the manner of a shoe. When being drawn from tree to tree the wings of the tent are swung back, the lower end of the frame resting on a scantling and fastened by means of bolts working in a slot, the frames being braced by ropes, one on each side. In windy weather some difficulty is experienced in handling this as all other tents. The cloth falls on the ground and laps sufficiently to cover both ends where the two frames meet.

On the whole, I believe it the best appliance for covering small and middle sized trees, but I should not recommend it for trees larger than twelve to fourteen feet. The frame of the tent I operated with was twelve feet high. The Titus frame and tent were the ones used by Mr. Morse in his experiments. This apparatus is well described by Mr. Coquillett in his report as follows:

THE TITUS FUMIGATOR.

This apparatus was devised by Mr. L. H. Titus, of San Gabriel, and is especially designed for operating on tall trees, and consists of four corner posts made by bolting together two boards in such a manner that they form a right angle with each other; at the upper ends these posts are connected by crosspieces formed of boards bolted together like those forming the corner posts. Two of these crosspieces are longer than the other two, and are placed on opposite sides of the frame; they are connected near the middle by two crosspieces, between which is placed the roller upon which the tent is to be wound when being drawn off the tree. These various crosspieces are braced, as shown in plate.

The lower end of each of the rear corner posts is rigidly attached to an axle, on the outer end of which a light wheel is placed, while the inner end is connected with the corner post by an oblique brace. The lower end of each of the front corner posts is attached to the middle of an axle having a light wheel at each end. The post is attached to the axle by an iron bolt, which permits the wheels to be at the same moment turned, the one forward and the other backward, like the forward wheels of a wagon or buggy. By means of this arrangement the fumigator can be turned about in a circle. The front and rear corner posts on each side of the fumigator are connected with each other by a crosspiece extending from one to the other, and strengthened by braces which extend obliquely from the crosspiece to the posts.

When this fumigator is in use the front and rear crosspieces, as extending from the posts on the other side to those on the other, are removed, so as to permit the frame to pass either forward or backward over the trees.

The top of the tent is attached by three ropes to the roller, while to the lower edge of the tent are attached four ropes, placed at equal distances from each other; each of these ropes passes through a pulley attached to a frame near each upper corner, and the end of the rope is attached to the lower edge of the tent at the place where the opposite end of the same rope is attached. For winding the tent upon the roller an endless rope is used this passes around a grooved wheel at one end of the roller and is carried through a pulley near the upper end of one of the rear corner posts; from this point it passes to and around a grooved wheel fastened to the crosspiece near the lower end of this post, and this grooved wheel is operated by a crank.

In taking a tent off of a tree each of the corner ropes is pulled through its pulley, drawing the bottom of the tent upward, thus turning the tent inside out; after the tent has been drawn up as far as possible, the crank operating the grooved wheel that works the endless rope is turned, winding the tent upon the roller until it has been entirely removed from the tree. The fumigator is thus drawn forward until the tent is brought directly over the second tree, when the ropes attached to the lower edge of the tent are loosened, permitting the tent to drop down over the tree, at the same time unwinding the tent from the roller, and continuing this until the tent rests upon the tree.

The Generator.

The generator consists of castings and pipes and was made by George Cumming & Co., but was devised by Mr. Morse. It consists first of an earthenware jar, which is held firmly by means of a frame, the joint being made tight by means of heavy felting. Through this board two pipes pass connected with receivers, one for the cyanide and one for the acid. When by pouring the acid on the cyanide the gas is given out, it passes onward through a four-inch pipe, which connects with the drier a large iron cast-

ing, six by eighteen inches, which is filled with pumice stone moistened with sulphuric acid, and is made so that it can be revolved for the purpose of bringing all particles of the pumice stone in contact with the acid. Through this drier the gas passes onward into pipes, which lead into the tent. Parallel with the pipe, passing toward the drier and connected by an elbow, is a galvanized iron pipe, on top of which is fastened a Cumming fan blower. The blower can be made to act two ways by means of a circular valve, this being moved by a rod. The blower blows forward through the pipe, which meets the gas which has passed through the drier, driving it into the tent. The object of the valve is to prevent the escape of any gas which has not passed through the drier and which might contain ammonia. The suction pipe of the blower passes directly into the tent, and consequently when the gas is in the tent it is kept circulated when the blower is at work.

The experiments on orange trees ranging from eight to twelve feet high were made during the months of June and July of 1888, near San Mateo, at the grounds of H. Barroilhet, Esq., who kindly furnished me with assistance in transporting the machinery and putting it up, also in helping to operate the apparatus. Owing to the trees being very near together it was impossible to use horse power in moving the tent, and this made our progress very slow and tedious. Strong winds interfered also, very seriously tending to make the tent leak. The tests were made during all kinds of weather, from 60 degrees F. to 85 degrees F., calm and windy, and when the drier was well saturated with acid no harm was done to the tree; young fruit even during a confinement of forty minutes during the noon hour, not being affected. On the other hand, when for the lack of sulphuric acid the drier was not sufficiently charged, serious harm resulted, the foliage in a couple of days falling off. This was especially the case when the operation was done during the middle of the day, but bad effects also resulted when done in the evening as late as 7 P. M. at a temperature of 60 degrees. The effect on the icerya, which were present in immense quantities, was nearly the same when a tree was confined for twenty-five minutes, as when for forty-five minutes, only the bugs themselves and from 50 to 75 per cent of the eggs are killed. That the prevailing wind may have had a good deal to do with my failure of doing better at such times is possible, but I am satisfied from general results that when orchards have to be treated on a large scale it will be found necessary to give two treatments for extermination, and I should recommend in accordance with this view that these two treatments be given at four-week intervals, which will give an opportunity for remaining eggs to be hatched.

Cost of Treatment.

Placing cyanide of potassium at 50 cents a pound and acid at 8 cents, we have the solution of cyanide at a cost of 1 cent, and acid per ounce $\frac{9}{16}$ cents, making it 27½ cents for a twelve-foot-high tree for one treatment.

On level ground two men and one horse can handle the tent and treat two trees per hour, allowing twenty-five minutes for the dose to act and five minutes for moving and getting ready. One horse, 50 cents; one man, $2; one man, $1 50; total, $4; or an expense of 20 cents per tree.

If two apparatus are used they can be worked with the same force, making the expense but half, or 10 cents, apiece when forty trees are being treated once, or for two treatments 20 cents each. To this add the cost of material, which would, for a twelve-foot-high tree, be 55 cents. Besides this, there must still be added the price of labor of putting on proper bands.

For this purpose sheepskin has been found to be the best; strips four inches wide. A skin, costing say 30 cents, will make ten.

It must, however, be remembered that bands must necessarily be placed on trees that are being sprayed, and therefore must not be counted as an expense exclusively attending the gas treatment, being common to both spray and gas process.

MEALY BUGS.

Order, Hemiptera; Family, Coccida.

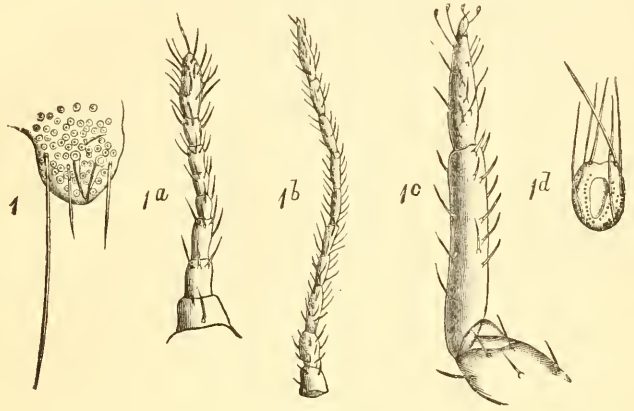
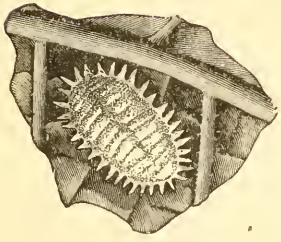


Figure No. 23.



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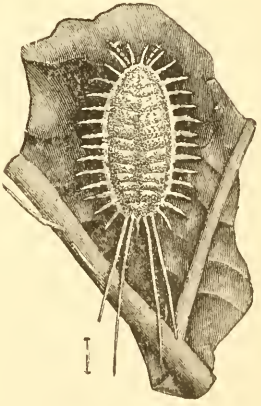

Figure No. 24.

Figure 22, Dactylopius Destructor; Figure 23, Dactylopius Adonidum; Figure 24, Dactylopius Longifilis.

Allied to scale insects, and at times equally destructive, are the mealy bugs, of which the genus *Dactylopius* is a representative. The figures give a good idea of these insects. They are soft and of a pale pink color, generally covered with a mealy powder, hence the name. The common species, *D. adonidum*, is found nearly in every greenhouse in the world, and in Californian climate survives on many kinds of plants and have at various times proved quite troublesome in Los Angeles County on oranges. It

has at times disappeared, and it is more than likely that it has been destroyed by the *Scymnus marginicollis*, figured under the head of useful insects. A species of *Scymnus* is reported by Professor Comstock to destroy them in Florida. Unless checked by natural enemies, the mealy bugs multiply very rapidly, and mass themselves in the corners of the leaves. The plants turn black from the fungus growth growing on the honeydew, and the bush presents the same appearance as a scale-infested plant.

Remedies.

The most successful remedies I know of are the rosin solutions recommended under the head of the fluted scale.

CHAPTER II.

GENERAL REMEDIES FOR SCALE INSECTS.

Winter washes—Modes of preparing—Condition of trees for spraying—Time of application—Caustics—Summer remedies—Proportions of ingredients—Kerosene emulsion.

WINTER WASHES.

For Scale Insects on Deciduous Trees.

The wide difference in the atmospheric conditions in the different parts of the State has proved, as might be expected, that different remedies will be found suitable to different localities. When comparing the efficacy of a wash used in one locality, with that of another in another locality, we are apt to be misled. Only by trying the same remedy in different localities can definite conclusions be reached. As a general thing, the caustic remedies have been used with good success in the more cool and moist climates of the coast. When well applied, they must be considered among the best and most efficacious we have. On the other hand, they have been generally less successful in the interior of the State, where a dry atmosphere prevails for a longer time.

In using caustic washes the following points must be especially taken into consideration:

1. Condition of trees.
2. Time of application.

1. Trees must be dormant; otherwise the fruit buds, especially when advanced, will be damaged.

2. A humid atmosphere, without being actually so as to cause water to run down the trees, is much more preferable than very dry weather; in fact, as was proved last season, actual damage has been done to trees when wash has been applied during such weather, and the results in killing the scale have also been unsatisfactory under such circumstances.

While we still believe that the caustic, in the proportions given below, when used under precisely favorable conditions, is as sure and wholesome a remedy as we can apply to apples, pears, and plums, the simple whale oil and sal soda remedy, especially for peaches and cherries, has proved very efficacious; but great care must be exercised in applying it, as the oil is apt to separate unless well stirred, and the compound kept warm.

FOR PERNICIOUS SCALE.

Aspidiotus Perniciosus.

For badly infested orchards I recommend: One and one quarter gallons of whale oil; twenty-five pounds of sal soda; dissolve the sal soda in twenty-five gallons of water and heat it to boiling. When boiling pour the whale oil in. Apply the wash when cooled to 130 degrees F. The whale oil forms a kind of emulsion, most of the oil remaining free. After allowing this dose to act for three or four weeks, apply caustic solutions in this proportion: One pound of concentrated lye (American), of 80 per cent; or four fifths of a pound of powdered caustic soda, of 98 per cent; or one pound of solid caustic soda, of 76 per cent; or one and one half pounds of solid caustic soda, of 63 per cent. Any one of these to one half pound of commercial potash, at 52 per cent. To be dissolved in six gallons of water.

Mode of Preparing Washes.

The easiest way to prepare the alkali washes, especially the solid concentrated lye, is by suspending the material in a barrel of water, either putting it on a perforated piece of tin or colander. Being thus suspended the diffusion is quite rapid, and the material will require but little looking after. By using hot or boiling water the action, of course, is hastened very much. When dissolved thoroughly, each kind having been kept separately, they are mixed and stirred well, so that they become thoroughly mixed. The liquid should be strained through a fine sieve (brass) or a cloth, so that no clogging is possible when the wash passes through the nozzle.

The San José nozzle has been and is very generally used, but for lye washes it is, in my opinion, inferior to the Imperial and the Cyclone. The latter has the advantage of throwing the stream better on the underside of branches and foliage. When a pump with two outlets is at work, the two kinds of nozzles may be used to advantage. One man may work principally on the upper part of the tree with the Imperial (because its spray, being thrown straight, hits the more vertical branches squarely), while the other man will reach the lower more horizontal branches with the Cyclone spray, carrying, as it does, either upward or downward.

A very good nozzle is that invented by John Crofton, and sold by H. P. Gregory and Woodin & Little. It has the advantage of clearing itself by a turn of the bib. Its spray is similar to that of the Cyclone nozzle.

Caustics.

The object to be obtained by using the caustics after the sal soda and whale oil is to saponify any oil that might have remained on the tree, and which would have a tendency to clog the pores of the bark. I believe this treatment will prove the most efficacious yet recommended.

The cost of whale oil is 30 cents a gallon, in fifty-gallon barrels; 35 cents in cases. As to caustic, it must be remembered that the price will vary according to quantity, and that the purest product is the cheapest. The green bank, 98 per cent, is considered the best and the least varying; next to this, American concentrated lyes; George F. Lewes, Menzies & Co. seem to be most reliable.

In the moist coast counties we would recommend the caustic in this proportion for pears, apples, and plums, the trees to be perfectly dormant: One pound of solid concentrated lye (American), of 80 per cent; four fifths of a pound of powdered caustic soda of 98 per cent, one pound of solid caustic

soda of 76 per cent; one and one quarter pounds of solid caustic soda of 63 per cent. Any one of these to one half pound of commercial potash, at 52 per cent. To be dissolved in four gallons of water; one quarter of a pound of whale-oil soap (80 per cent) to each gallon of mixture.

For peaches and cherries, and in the drier localities, whale oil and sal soda in this proportion: One gallon of whale oil to twenty-five pounds of sal soda; twenty-five gallons of water. Prepare the same as above.

For the different kinds of lecaniums, such as the black scale and brown scale infesting deciduous trees, slightly weaker solutions than those used for the pernicious scale may be used with good effect. As regards the many different kinds of solutions used and offered for sale, the best advice is to not experiment too much, on a large scale at least. If by experience in the locality certain remedies have proved themselves reliable, they had better be adhered to. In using new remedies use them only on a few trees, and allow a season to pass before you consider that you are sure of their efficacy and influence on the tree. As a general thing, compounds that are very sticky and oily, remaining for a long time in such a condition on the trees, should be very cautiously dealt with until their nature and composition are better understood. Especially are these dangerous to the stone fruits, and unless properly diluted will prove positively fatal.

As regards the use of kerosene as an insecticide, the greatest danger is to the roots. It should only be used as an emulsion with soap, or as a component part of the soap.

SUMMER REMEDIES.

Solutions are applied with best results when the majority of the insects are hatched, and persons should watch for this time; the first brood of the *Aspidiotus perniciosus* appears generally when the cherries are turning color.

As a general useful wash the sulphide of soda or sulphide of potash, with whale-oil soap, has proved very satisfactory. One and one half pounds of sulphur; one pound of concentrated lye, *or* powdered caustic soda, four fifths of a pound; or caustic potash, one pound; fourteen pounds best whale-oil soap (80 per cent soap); fifty-five gallons water. Dissolve the lye in one gallon of water, and boil the sulphur until dissolved. Dissolve the soap in the water; mix the two and boil them a short time; use at 130 degrees F. in vessel.

I do not hesitate to recommend this solution also for orange and lemon trees infected with the various lecaniums, and, if properly used, also for the red orange scale. It is, however, not to be expected that on an orange tree, with its dense foliage, these insects could be exterminated. This can only be done by cutting the tree back in the spring and washing the trunk and main limbs most thoroughly.

For the red scale the gas process described under the head of the fluted scale is absolutely the most thorough, and we are glad to learn that leading growers are preparing for it.

Another solution, first recommended by Mr. B. M. Lelong and tried pretty thoroughly by people on the Sacramento River, is the following:

For Scale Insects on Deciduous Trees— Sprayed on Fruit.

Ingredients for one barrel of fifty (measure) gallons: Weight, about four hundred and fifty to five hundred pounds; ten pounds caustic soda, 98 per cent; ten pounds potash; forty pounds tallow; forty pounds rosin. *First*—Dissolve the potash and soda in ten gallons of water. When dissolved, place the whole amount in the barrel to be used. *Second*—Dissolve the

tallow and rosin together. When dissolved, add the same to the potash and soda in the barrel, and stir well for five minutes or so. Leave standing for about two hours, then fill up with water, stirring well as every bucket of water goes in. Use the following day, one pound to the gallon of water; apply warm. This remedy is best adapted to pears and apples.

I append also here the receipt for Professor Riley's kerosene emulsion, to which reference is made in various places:

Kerosene, two gallons=67 per cent; common or whale-oil soap, one half pound; water, one gallon=33 per cent.

Heat the solution of soap, and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling and should adhere, without oiliness, to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of hot water. The above formula gives three gallons of emulsion, and makes, when diluted, thirty gallons of wash.

CHAPTER III.

LEPIDOPTEROUS LARVA BORING IN FRUIT.

Codlin moth—Remedies for—Paris green—London purple—Sulphur—Measures to catch the larvæ—Picking off infested fruit—Thissell's moth trap—Measures aiming at the destruction of the moth—Remedies aiming at the destruction of the hibernating larvæ—Parasites and predaceous insects—Peach moth.

CODLIN MOTH.

Carpocapsa Pomonella. (Fig. 25.) Order, Lepidoptera; Family, Tortricidæ.

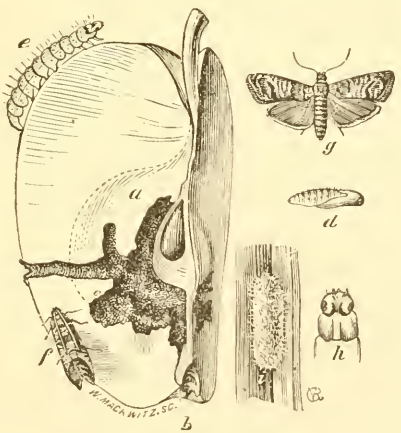

Figure No. 25.

Description.—*a*, section of an apple ruined by the burrowings of the larvæ, and channel by which it leaves, when full grown, at the left; *b*, the point at which the egg, for the first brood, is usually laid, and at which the young worm enters; *c*, the worm or larva, full grown, with black or brown head, body white when young, cream colored at maturity, and pink just before changing to chrysalis; *h*, head of larva magnified; *i*, the cocoon which it spins, usually under a scale of bark; *d*, the chrysalis to which the larva changes in the cocoon, of an amber or chestnut-brown color; *f*, the moth which escapes from the chrysalis, at rest; *g*, the same with wings expanded.

Size of moth: Length, seven sixteenths of an inch; spread of wings, nearly three fourths of an inch. Color of moth: Body, richly bronzed light drab; fore wings, mottled gray and drab, with dark coppery bar across hind margin, or a golden eye spot near inner angle; hind wings, plain drab, a little darker than body. Cocoon: White inside, but usually so covered with minute pieces of surrounding bark, etc., as to be overlooked by a careless observer.

The ravages of this insect are perhaps better known and more widely spread than those of any insect. Its original food plant is the apple, which it prefers, but the pear and quince are almost equally subject to it. The moth makes its appearance in May and June, when it deposits its egg in the blossom end. The young worm hatches in seven to ten days, and eats its way into the fruit, and in twenty days its full growth is attained, and it goes out through the side of the apple and, by means of its spinneret, reaches the ground or some large branch. If landed on the ground it usually seeks the trunk, which it ascends and soon finds a hiding place under the loose bark, where it spins its cocoon, and in eight or ten days comes forth a moth, ready to lay eggs anew. As there is not at this time offered as distinct and conspicuous place for it to deposit its eggs as when the blossom end was pointing upward, the egg is laid all over the fruit, and especially at a point where two fruits touch. Usually we have in this State two broods at least, but more often three, and naturally, if unchecked, the increase from the first to the last is enormous. The worms escaping from the fruit in the fall hibernate as larvæ under the loose bark in storehouses or any available dry place.

The natural habits of this insect have led us to adopt various remedies, which may be classed thus:

1. Those aiming at killing the young larvæ while in the fruit.
2. Those aiming at destroying the mature larvæ.
3. Those aiming at destroying the moth.
4. Those aiming at destroying the hibernating cocoons.

Measures to Kill Young Larvæ while in the Fruit.

Sprayings.—This mode of protection is evidently the most promising of any, and, in the East, where it has been tried for a number of years, it has given quite satisfactory results. Of these solutions the arsenic compounds have been the preferable.

Paris Green, London Purple, White Arsenic.

Paris Green.

Paris green is a compound of arsenic and copper. It is a far more powerful poison than arsenic alone, and is not soluble in water, hence will remain much longer on the trees. As stated before, in the Eastern States it is used in preference to arsenic, as it is not so liable to be washed off by rain, and another advantage is that it is not so liable to hurt the foliage.

The spraying should be done for the first time just when the flower leaves are falling; used then very little of the poison will adhere to the leaves, they being, as a rule, comparatively undeveloped.

The strength to be used for this first spraying may be safely put down at one pound to two hundred gallons, assuming that the Paris green will contain 55 per cent of arsenic. When used much later it must be diluted to one pound to three hundred gallons. For early ripening apples one spraying ought to be sufficient, unless, as sometimes happens, the blooming is very irregular. For winter apples it is advisable to give a second spraying before the apples commence to turn downward. As regards the strength safe to use, it must vary according to locality and variety of apples. In the damp coast counties, where often heavy night fogs prevail, it should not be used any stronger than one pound to three hundred gallons; in the drier valleys it seems safe to use it stronger. Certain varieties seem very

liable to have the foliage burnt; especially is this the case with the Yellow Bellflower.

In using the Paris green it has been found convenient to mix a few pounds of soap to the barrel. This helps to keep the Paris green suspended, otherwise it settles very rapidly and only continual stirring will keep it afloat. In spraying a fine nozzle should be used and the aim should be to wet every blossom.

I am opposed to the use of Paris green, when used later than the time of the apples turning on their stems. Too much poison may lodge on the apples by the stem-end, rendering it decidedly dangerous. For a third spraying whale-oil soap and sulphide of soda is preferable. Although not an active poison, it seems to deter the moth from laying its eggs, and those laid are nauseated by the compound.

London Purple.

London purple is another arsenical compound. It is the residue from the manufacture of analine dyes, and contains lime, arsenious acid, and carbonaceous matter. It is more soluble, more adhesive, less poisonous, and especially for the last reason has its strong advocates.

However, its very solubility makes it much more destructive to foliage, and in moist localities it is unsafe to use, except when the foliage is very little developed. Arsenious acid, it is contended, can be used with as much safety as any of the other compounds, but its innocent appearance is an objection, when the carelessness of the average man is considered. I have used it at the rate of one pound to six hundred gallons, applied early in the season.

Sulphur.

In a report of a horticultural institution in Germany—Geisenheim-on-the-Rhine—R. Goethe, Director, I find record of partial success, obtained by scattering sulphur a number of times on the fruit.

Measures to Catch the Larvæ.

Banding System.—This mode of protection, which has been practiced in the Eastern States, has been tried in this State more than any other. Its usefulness is based on the observed habit of the larvæ when leaving the apple to seek shelter under the bark. The band about the tree provides artificial shelter for the worm, and the majority of the larvæ, no doubt, find their way to this; but a sufficient number for giving future trouble find other hiding places on fences, buildings, etc., and perhaps more than anywhere else under clods at the foot of the tree; and it is here, in an old orchard, that I have almost invariably found cocoons. To make the banding system more effective, the ground right around the tree, as well as the whole orchard, should be thoroughly pulverized. The greatest obstacle to the success of the banding system is the neglect of one orchard owner, while his neighbor conscientiously and thoroughly performs the work. The neglect or half-done work of one person among his trees, is sufficient to counterbalance the attentive and thorough work of many others around him. It is evident that in a thickly settled community, unless all concerned do their duty, the work will be largely in vain.

Picking off Infested Fruit.

The practice of picking off infested fruit, of course comes under the same head as the band system. In that it aims at a reduction or extermination of the next brood, it should go hand in hand with the band system. It is also open to the objection that unless the neighbors do their duty little good is accomplished.

Thissell's Trap.

The so called moth trap, invented by Mr. Thissell, of Winters, is founded on the same idea as the band, but is arranged so that when the moth hatches it remains in the trap. This trap consists of a collar of tin, to which a piece of wire cloth is attached. The collar is in the middle, so as to hold the wire away from the tree. A piece of sack is placed around the tree. The wire cloth is gathered above and below the collar and fastened

closely to the tree with tacks. The meshes are just large enough for the larvæ to enter. To make allowance for the larvæ above the average size, the tin collar at the middle is perforated with holes slightly larger than the wire meshes. The moth when hatched can not possibly escape, but remains to die in the trap. The trial I have seen was very satisfactory—all the larvæ placed on the trunk finding their way directly into the trap. It will be seen that this trap saves all the work of searching the bands, which in itself amounts to a great deal. The absolute necessity of looking at the bands at shorter intervals makes the system extremely annoying, as all other work of the time must be laid aside for this. On the other hand, Thissell's trap is rather expensive, being from 15 to 30 cents, according to the size of the tree. It has also the objection that it does not allow for the expansion of the tree, a fault quite serious when young trees are to be protected.

Measures aiming at destruction of the moth.

Light to attract the moth.—This means, aiming at the destruction of the moth, has been least successful of all. From the testimony of the best observers, both here and in the East, we may conclude that the number of codlin moths caught and killed by light is very small, as compared with the number of other night-flying insects, many of which are useful. The device—a lamp above a can of oily mixture—in my judgment has been no more successful than others on the same principle.

Cans filled with vinegar and molasses, or other similar compounds.—This device, it seems to me, has been least successful of all, attracting all sorts of insects but the ones most of all desired. It must be regarded as a failure.

Remedies aiming at the destruction of the hibernating larvæ.

To prevent any larvæ from hibernating on trees, all old loose bark should be scraped off and the ground treated to a depth of six inches below the surface. If the trees are covered with lichens, which is very often the case, the spraying of the trees with an alkaline wash will be of excellent service, killing any that might be there, and also invigorating the tree. If potash is used, one seventh of a pound of concentrated lye and one quarter of a pound of potash to one gallon of water is a good mixture.

NOTE.—The experience of last summer has demonstrated the necessity of removing the second crop on apples and pears. In many varieties of apples, as well as in pears, there s a delay of eight or ten days before some of the weaker fruitspurs push. These will be eached with the second spraying. But besides this, there are on some varieties of apples, or instance the Esopus Spitzenberg, a distinct second flowering, fully a month after the rst. As this seldom develops good fruit and first invites the codlin moth, the easiest way to dispose of them is to clip off the whole fruitspur when in bloom. The neglect of doing this has been to counteract the influence of the spraying altogether, what many persons have learned to their sad experience this year.

In early fruit sections, such as the Sacramento River, the removal of the second crop of Bartlett pears has, according to the experience of Sol. Runyon, Esq., one of the most successful growers there, the influence of checking the codlin moth, so much so that the damage to the next year's first crop is comparatively slight.

Parasites and Predaceous Insects.

In report of the Department of Agriculture, 1887, Mr. L. O. Howard says:

Of true hymenopterous parasites at least three species have been recorded in Europe and two have been bred in this country. The European species are *Phygadeuon brevis*, Grav.; *Pachymerus vulnerator*, and *Campoplex pomorum*, Ratz.; all ichneumonids. The species which infest it in this country are also ichneumonids, and are *Pimpla annulipes*, Br., and *Macrocentrus delicatus*, Cress. Both of these insects were first recorded by Professor Riley, who reared them from the codlin moth in Missouri in 1872. The *Pimpla* is quite a widespread species in all parts of the country, and is not by any means confined to the codlin moth. Professor Riley has recorded it from the walnut case-bearer (*Acrobasis juglandis*) and has also reared it from the cotton worm of the South (*Alctia xylina*) and from *Grapholitha olivaceana*, Riley; *Coleophora cinerella*, Cham.; *Orgia leucostigma*, Har., and an unknown loaf-roller on ash. It does not seem to spin a cocoon, but eats its way out of the pupa in which it has transformed, usually coming out of the anterior part.

Recently it has been sent to us from Alameda County, California, where it was reared from the codlin moth pupa by Mr. Koebele. The *Macrocentrus* is, so far as we know, confined to this one host. It is apparently a more efficient destroyer of the pest than is the *Pimpla*. We have seen large series of individuals in several collections, and it is as common at the East as it is in the West. It spins a tough brown cocoon within that of the *Carpocapsa*.

There are a great many predaceous insects which feed upon the larvæ while they are searching for suitable places to spin up, and upon the pupæ, which are poorly protected

by the delicate cocoon. None, so far as we know, seek the larva in the apple. Professor Riley states that the Pennsylvania soldier-beetle (*Chauliognathus pennsylvanicus*, DeG.), and the two-lined soldier-beetle (*Telephorus bilineatus*, Say), in their larval states feed upon the larvæ of the codlin moth after they have issued from the apples. He also mentions the fact that the larvæ of a species of *Trogosita* also helps in this good work. Dr. LeBaron treats of this insect at some length, but of late years it has not been found. The species has never been determined. Mr. Koebele has recently sent us from California two Dermestid beetles, which are stated to destroy the pupæ of the codlin moth. These are *Trogoderma tarsale* and *Perimegatoma variegatum*. Experiments made indicate that they will kill the chrysalids in confinement, but as to destroying them in the open air on trees we have no absolute evidence. Mr. Koebele has, however, been instructed to make close observations upon this point. An undetermined soldier-bug was observed by Mr. G. W. Shaw, a correspondent of Dr. LeBaron's, who states that he has actually observed the bug to pierce an apple with its beak and draw out the apple-worm, which, however, is a statement which may be taken with a great deal of allowance. An unbred and undetermined coleopterous larva was received by Professor Riley, in 1874, from Professor A. J. Cook, with the statement that it fed upon both larvæ and pupæ of *Carpocapsa pomonella*. This larva, according to Professor Riley's notes, bore a close resemblance to that of the Clerid *Necrobia rufipes*—the red-legged ham-beetle.

Both the *Pimpla* and *Macrocentrus* are figured in the report of the United States Department of Agriculture of 1887.

PEACH MOTH.

Order, Lepidoptera; Family, Tineidæ.

Anarsia lineatella, *peach moth*, or *strawberry root borer* (Figure No. 26), which has of late become quite a serious pest in our orchards, has likely been imported on strawberries. on the roots of which it feeds in the Eastern States. I am not aware that it has proved anything troublesome to the strawberry growers, although it is possible that it does some damage. It must not, however, be confounded with the borer generally infesting strawberries in this State, which lately has been determined by Professor Riley to be the larvæ of a clear-winged moth (*ægeria impropria*. H. Edwards).

As the insect demands general attention, we have deemed it well to have an illustration of it, copied from Saunder's "Insects Injurious to Fruits," from which I also take an account of its habits in the Eastern States.

When occurring in great numbers, this insect is very injurious, playing sad havoc with the strawberry plants. The borer is a small caterpillar, nearly half an inch long, and of a reddish-pink color, fading into a dull yellow on the second and third segments; the anterior portion of the second segment above being smooth, horny-looking, and brownish yellow, like the head. On each segment there are a few shining, reddish dots, from every one of which arises a single, fine, yellowish hair. The under surface is paler. This borer eats irregular channels through the crown, sometimes excavating large chambers, at other times tunneling it in various directions, eating its way here and there to the surface. If examined in the spring, most of the cavities will be found to contain a moderate-sized, soft, silky case, nearly full of castings, which doubtless has served as a place of retreat for the larvæ during the winter.

Early in June, when mature, the caterpillar changes to a small, reddish-brown chrysalis, either in one of the cavities excavated in the crown, or among decayed leaves or rubbish about the surface, from which the moth escapes early in July.

The moth is very small, of a dark-gray color, with a few reddish-brown spots and streaks on the fore wings. The fringes bordering the wings are gray, tinged with yellow. The moth lays an egg on the crown of the plant late in July or early in August, which soon hatches; the small caterpillar burrows into the heart of the plant, and remains in one of the chambers during the winter, occupying one of the silky cases referred to. The

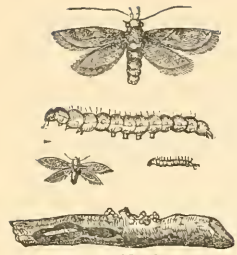

Figure No. 26.

channels formed by the larvæ through the crown and larger roots of the plant soon cause it to wither and die; or, if it survives, to send up weakened and almost barren shoots. This insect does not limit its depredations to the strawberry; the larvæ is also found boring into the tender twigs of the peach tree and killing the terminal buds.

In the figure I have a representation of the larvæ and moth, both of the natural size and enlarged; also of an injured peach twig.

This insect is known to attack the peach tree in Europe, whence it has probably been imported to this country.

It is seen that the insect is subject to parasites. This may account for its disappearance in localities, and then again its presence; although the tendency seems to be that it is gradually spreading over the State. In several localities it has been so bad that half of the peach crop was infested.

In Dr. Chapin's report of 1883, Mr. W. H. Tucker, of Folsom, is made the authority for the statement that it has been observed for sixteen years in Pleasant and Vaca Valleys. Five years ago it was first noticed on the University grounds. Young growing apricot shoots were found withering at the ends, and upon examination the larvæ were found in them. All the branches showing these signs were cut off and burned. After careful search I found only two branches the next season, and since then they have not been seen here. Evidently parasites must greatly have helped us, otherwise we should never have been so easily rid of the pest. The peach moth requires more study before it will be possible to indicate the best line of defense against it. The larvæ are found under the bark of the tree, but from its habits as a root borer it is plain that some of them must harbor in the ground. It will be well to clear the trees of all of their rough bark in winter. In the spring all young twigs showing their presence by wilting should be removed and burned. Where the insect has not yet been known, the strictest caution should be observed against bringing any fruit boxes from sections known to be infested.

CHAPTER IV.

MOTH LARVA BORING IN THE WOOD, TWIGS, AND ROOTS.

California peach root borer—Remedies for—Strawberry root borer—European currant borer.

CALIFORNIA PEACH ROOT BORER.

Sannania Pacifica (Riley).

My first information of this new pest came from Mr. John Britton, quarantine guardian for Santa Clara County, who sent me, under date of May twenty-second, chrysalids and larva, and a mutilated specimen of a female; mentioning in his letter that this borer had killed a number of trees and that a number of orchards were affected. In his company I visited, some days after, the locality, a couple of miles southeast of San José, and satisfied myself about the dangerous character of this insect. Some two weeks after, in the month of June, I visited the infested orchards again, in com-

pany with Mr. A. Koebele and Mr. H. A. Brainard, and we obtained a number of larva and chrysalids, which Mr. Koebele took charge of. In course of a couple of weeks both male and female were developed, and it became plain that this was a different species from the eastern peach borer, and specimens were forwarded by Mr. Koebele to Professor Riley for identification.

Under date September 4, 1888, I received a communication from Professor Riley, in which he says: "The *Ægereid* to which you refer I shall describe under the name *Sannania pacifica*, as it connects through *S. exitiosa* (eastern peach borer) with *S. Fitchi*."

Not having yet received Professor Riley's description, and desirous to give the readers an idea of this important insect, I have described it in a rough way myself. Whence the insect came I can only conjecture, but the supposition is that it is a native insect that has existed on some wild bush and gradually has taken to the peach trees in the neighborhood, according to the statement of Mr. Leigh, whose orchard has suffered for many years.

Description.—Larva (Figure No. 27), pale yellow, with brown head; about an inch long. cocoon (Figure No. 28), brown, as all ægerias; made up of the castings and glued together; one and one quarter to one and one half inches long. *Female* (Figure No. 29), fore wings, bluish-black opaque; hind wings, transparent veins; black fringes of both wings dark; antennæ, dark steel-blue; head, thorax, and abdomen of a uniform very dark blue, almost black, the segments marked with a faint blue line; tuft on the abdomen jet black; legs black; span of wings, one and one half of an inch. *Male* (Figure No. 30), fore wings partly transparent, upper margin black, ends black, a dark bar transversely across the veins past the veins, past the middle; hind wings transparent; fringes of both wings black; antennæ steel blue; head and thorax black; abdomen steel blue, lighter colored on the segments; tuft black; legs black, with yellow tuft of hair on thigh and on tibia; wing span one and one quarter inches.

Figure No. 27.

Figure No. 28.

Figure No. 29.

Figure No. 30.

The habits of this insect are similar to those of the eastern peach root borer, yet it differs essentially and in such a manner that it must be considered less dangerous.

The tunnels of this borer are almost vertical, varying from four to eight inches in depth, by three to four inches in width, and the disposition to girdle the tree does not seem to be so apparent as by the eastern borers. Frequently five or six borers were found which had not girdled the tree yet. Furthermore, it does not seem to work above ground. Its presence was noted especially on heavier land, while on very light, sandy soil it was notably absent. Its presence is also invariably indicated by copious gum exudations below ground. Its preference is peach roots, yet I found instances where cherries (Mazzard stock) had been affected.

Remedies.

The moth lays its eggs at the base of the tree, in the months of May and June, and by preventing access to this we have a remedy. The fact of their presence being hardly felt on light, sandy soil points to the advisability of the placing of sand from four to five inches deep around the base of the tree. But better than this would be a complete wrapping of the trunk, from several inches downward to six inches upward, with stout paper or paraffine paper, which is tied well or held in place by a collar of mortar.

Remove the earth from around the tree to the depth of a few inches and a few inches from the tree, and fill the basin with air-slacked lime, piling it up a couple of inches above ground. Possibly ashes may serve the same purpose. All trees affected should have the wounds plastered over with damp clay after all the worms have been killed, and then protected as indicated above.

I do not favor the use of gaslime—it may do as much harm as the borers themselves.

CALIFORNIA STRAWBERRY ROOT BORER.

Ægeria Impropria. Order, Lepidoptera; Family, Ægeridæ.

Fore wings, bronze black (Figure No. 33), with the internal margin rather broad and inclosing an orange line. The intronervular marks of the posterior margin are also orange, as are the edge of the discal mark; fringes of both wings, bronze black; antennæ, steel blue; head and thorax, brownish black, with the collar and narrow lateral stripes pale yellow; abdomen, with second and fourth segments, edged posteriorly with pale yellow; caudal tuft, black above, orange at the sides, black beneath, except the tip, which is orange; palpi, yellow above, black beneath; tip also black; legs as in *Ag. perplex.* Figure No. 32, chrysalis.

Figure No. 31.

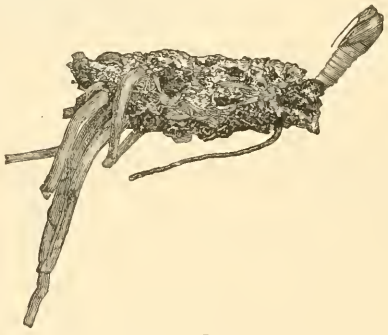

Figure No. 32.

Figure No. 33.

This insect is found in various portions of the State doing considerable damage, forcing the growers to resort to replanting much earlier than otherwise would be necessary. The life history of this insect has been but imperfectly studied, so as to be a proper guide for means of prevention. The grub (Figure No. 31) passes the winter through in the larva state, feeding on the root. In June, probably, the mature insect issues, which lays its eggs right at the edge of the ground, after the manner of other ægerias. The common practice of flooding the vines has a great tendency to kill out the worms, and if the water was retained, say four to five days during the winter, all over the plants, doubtless all the larvæ would be killed.

EUROPEAN CURRANT BORER.

Ægeria Tipuliforme. Order, Lepidoptera; Family, Ægeridæ.

Expansion of wings, eight to ten lines; color, bluish black; palpi, yellow; antennæ, black; thorax, with a yellow line on each side; the breast with a yellow lateral spot; the abdomen of the females with three and the males with four very slender transverse bands. The tibia are black, with a ring, and the tip yellow. The fore wings have the margins and transverse bar black; the tip dirty golden yellow, with black veins. The larva is of a whitish color, with the head and feet brown, and a dark dorsal line.

The following observations on this insect were made and recorded by Professor C. H. Dwinelle:

The female of the currant borer lays her eggs singly on the wood of a year old or over, and usually by the side of a bud or branch. When hatched the young larva makes its way into the center of the stem, and taking a downward course eats out the pith for a distance of several inches. The borer is of a general white color, with a brown head. There are a few short hairs scattered over the body. Besides six true legs, there are ten fleshy prop legs farther back. When full grown the borer is nearly one half inch in length, and slender in proportion. In spring the borers, for the most part, assume the form of chrysalis; but, with other borers of this class, there is a great deal of irregularity as to the time of making this change. At times the insect can be found in all three forms—larva, chrysalis, and mature moth. At the time for the moth to emerge the chrysalis assumes a dark-blue tint. It works its way to the opening of the burrow by a squirming motion, aided by sharp-pointed projections on the abdominal rings.

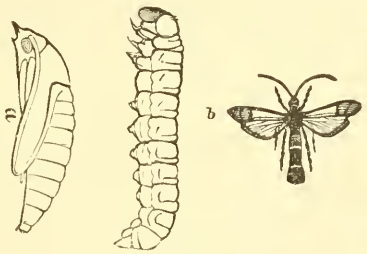

Figure No. 34.

This insect is common throughout all the currant districts of the State, and is one of the reasons of the short life of a currant plantation. To exterminate the pest is out of the question, but as remedial measures are recommended:

1. Pruning all of the wood above two years, and burning of the same.
2. Spraying of the vines with whale oil and sulphur, after the crop has been gathered.

CHAPTER V.

LARVA OF BEETLES BORING INTO THE WOOD OF TREES.

The flat-headed apple borer—Remedies—The sun-scald beetle—Twig borer—Wire worms.

THE FLAT-HEADED APPLE BORER.

Chrysobothris Femorata. Order, Coleoptera; Family, Buprestidæ.

This insect affects chiefly apples, peaches, and plums, but we have never found it on perfectly healthy trees.

The larva of this insect is pale-colored, with a brown head; the fore part of the body being greatly flattened. The matured beetle is greenish black or bronze colored, copper colored on the under side.

If any tree receives any damage to the bark, either by sunburn or other causes, the borer is sure to find it, and it works itself into the tree, its castings being the only guide to its presence. The egg is evidently laid in the surface of the bark, and the young grub hatches, working its way to the heart of the tree.

Remedies.

The best remedy is to prevent it from ever infesting the tree, which is done by carefully guarding the tree from being burned or harmed. For this purpose a three-foot long shake, split in two and placed on the south and west sides of the tree, answers the case well; wrapping with sacks may also be used, but it has the objection that the wrapping furnishes harbor for other injurious insects, such as the red spider and scale. A coating of whitewash, containing some soap and sulphur, is more preferable.

The training of a tree comparatively low, leaving a trunk of only eighteen or twenty inches, is one of the best preventives, but young trees must invariably be protected until the second year at least, and even after that time it will be well to shade the trunk of the tree.

In training trees low it must not be forgotten to bring out smaller branches on the lower portions of the main branches; otherwise, in a hot and dry climate, these branches will suffer on the main trunk, and become infested. The hotter and drier a climate is, the more care must be taken to protect the trunk.

If a tree has been only slightly attacked, so that half or two thirds of the bark can be saved, it will pay to take care of a young tree. If it go further than this, a tree will never become thoroughly sound, and will be outstripped in growth by young trees planted later.

Whenever a borer is removed, the debris and dead wood should be entirely cleaned out and the smooth surface left, taking care to preserve the bark as much as possible. Then the wound should be smeared over with grafting wax, and a rag tied about it. In this manner young trees have been saved, but unless only slightly attacked they have never done as well as younger trees uninjured.

There are other and similar species of borers found in the State, but they all, as far as we can learn, are only invited to damaged wood.

From time to time we have received a very large larva found boring in decaying roots. The parent of this is a large brown beetle belonging to the Longicorn family, and to the genus *Priunos*. It will not attack healthy roots.

THE SUN-SCALD BEETLE.

Xyloborus Xylographus. (Figure No. 35.)

Figure No. 35.

For some years it has been noticed that early in the spring trees, especially plums and apples, have suddenly shown all symptoms of drying. A close examination would generally reveal the bark clear to the sapwood in a state of putrefaction. Invariably the tree also would be found more or less pierced with minute holes, and in this the little beetle figured here would be found.

The close resemblance of this to the eastern blight beetle led me to believe that this insect was the primary cause of the tree failing; but I have recently arrived at the conclusion that the tree has been damaged to such an extent by the sun that the sap, being then rich in sugar, has fermented, causing decay, and that the insect has been attracted from this cause.

The remedy, therefore, here again, is having the trunk well protected. If trees are seen to be affected in this manner, they must be cut back to a few branches at once, and the wound dressed with grafting wax.

TWIG BORER.

Polycaon Confertus (Leconte). Order, Coleoptera; Family, Ptinidæ.

A chestnut-colored beetle, less than half an inch in length, with a very large head.

This insect is a native of this State, being found originally boring in oak twigs. Of cultivated trees its preference seems to be the olive, but it attacks nearly all kinds of trees, especially apples, plums, and prunes.

Figure No. 36.

Unlike other borers, this beetle bores in its adult state, cutting down into the one-year old twigs below a bud, and tunneling in for a number of inches into the wood. Its work is by no means fatal to the tree; but, unless proper pruning and attention be afterwards given, it will spoil its shape at least. My practice has been, whenever finding them, to remove the affected branches below the burrow of the beetle, provided the branch can be removed without harm to the tree. When it would be difficult to replace a branch, as is often the case, I should leave it on, but see that the beetle is destroyed and the entrance to the hole stopped up—this to prevent decay and a weak branch following.

Spraying with soap solutions will prevent their attack until the material leaves the tree, and may at times be used to advantage. The insect is kept in check by certain conditions, it seems, as its appearance is hardly noticed in some years. The present season it has been very troublesome, and while generally not seen after the middle of May, I have found it at work as late as the end of July.

Description.—The figure gives a good idea of this voracious and troublesome beetle, which can often be seen with half of its body buried in a twig, and with its strong jaws working farther in. Often when taken out it will bite viciously on the knife. Its general length is about one third of an inch or less, but it varies much in size. The color is chestnut brown. The head is conspicuously broad, almost merging into the thorax. I have never been able to find the beetle in its larval state.

WIREWORMS. (Figure No. 37.)

Order, Coleoptera; Family. Elateridæ.

Sometimes heavily-manured soil especially, becomes infested with small, slender, hard grubs, familiarly known as wireworms. These are especially damaging to succulent vegetables, but occasionally attack the young nursery stock.

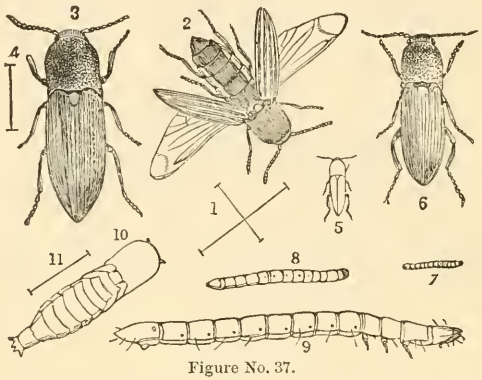

Figure No. 37.

A dressing of salt, at the rate of five hundred pounds to the acre, is beneficial for the purpose; and, in England gaslime, according to Miss Ormerod, has been also used with success. One thousand pounds to the acre could also be used with impunity, provided it is not thrown up against the plants.

The mature insect, which is developed from the wireworm, is the click-beetle, well known for the way it snaps its body together when touched.

CHAPTER VI.

LEAF-EATING CATERPILLARS.

Cutworms—Remedies for—Clisiocampa—Methods for destroying the caterpillars—The fall webworm—Arsenical poisons—Tussock moth—The red-humped caterpillar.

CUTWORMS.

Order, Lepidoptera; Family, Noctuidæ.

Sometimes, in the early part of the season, not only our vegetables and grapevines, but also young trees are completely stripped of their foliage, and the only trace of an insect at work we find is their castings. Upon scraping the loose dirt around the trees a fat, soft, dull-colored worm will be found. This is the so called *cutworm*, of which a number of species are found in the State, chiefly belonging to the species *Agrotis* and the family of *Noctui*, or owlet moths. In appearance and habits these cutworm moths resemble each other very much. They are nearly all dull-colored brown and gray mottled, changing in the ground to a brown chrysalis. The moth flies at night and the worm hides during the heat of day, working chiefly at night..

Remedies.

The following was recommended by the United States Entomologist some years ago, and seems to work well:

Take cabbage leaves and cut them up into pieces and dip them in a solution—one pound of Paris green to fifty gallons of water; put three or four pieces of this around the tree, one end in the ground. The worm will find them and eat them.

CLISIOCAMPA.

Order, Lepidoptera; Family, Bombycidæ.

There are several species of these resembling each other a good deal A species, presumably *C. constricta*, has been doing some harm this season in Sonoma County. This species is well described by the late Mr. Cooke, in his treatise on injurious insects:

The orchard of Mr. Delong, at Navato, Marin County, was infested last spring by caterpillars—a species of the genus *Clisiocampa*, or tent caterpillar. The caterpillar is one and three fourths inches in length. one fourth of an inch in diameter, and was full grown by the twelfth day of May. The body is sparingly clothed with soft and short hair, rather thicker and longer on the sides than elsewhere. The head is dark brown on each side, and dark brown above, leaving an inverted Y mark in the middle and front, jet black, and having much the appearance of a goblet, as one looks from its tail to head. The frontal mark is jet black, edged with a white strip across and over the mouth parts, and on each side of the inverted Y. The ground color of the upper part of the body is evidently blue, with a dorsal row of oval orange spots, one on each segment; two subdorsal orange lines; also, two lateral orange lines. The dorsal space not covered by dorsal spots; between the subdorsal lines is crinkled with fine black and orange lines; between the subdorsal and lateral lines, on each side, the space is blue, slightly variegated with fine orange and black lines intermingled. The lower part of the body and feet are dusky blue, crinkled with orange and black, irregular lines, and an amber-colored ring around base of prop-legs. The caterpillars do not make a tent or web, although they live in colonies on the tree. The caterpillars spin their cocoons (Figure No. 38) in the folded leaves of the trees on which they feed, especially the apple. Pupa elongate, posteriorly attenuated, inclosed in a loose silken web, suffused in fine yellow powder. The moth appears in about sixteen days; is reddish brown, with two transverse, rust-brown, nearly straight, parallel lines on the fore wings. Male (Figure No. 40), antennæ short curved, moderately bipectinated in both sexes, the pectinations gradually decreasing in length to the apex, and shortest in females; thorax, robust, pilose (hairy); abdomen, elongate, robust in female, and tufted in both; femura (thigh) and tibia (shin) hairy. It expands one and three fourths inches.

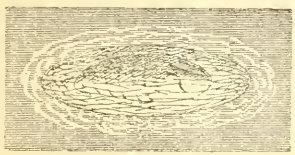

Figure No. 38.

Figure No. 39.

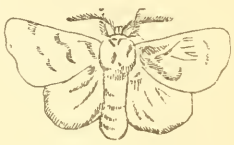

Figure No. 40.

The female moth (Figure No. 39) lays her eggs, about two hundred in number, in rows around the new growth of wood, and covers them with an apparent waterproof substance, to protect them through the winter season. About the time the leaves are unfolding in the spring the young hatch out and feed on the foliage and young fruit. Mr. DeLong had a block of two thousand apple trees completely stripped of fruit and foliage.

Method Adopted by Mr. DeLong for Destroying the Caterpillars.

He placed a band of butter-cloth about four inches wide, covered with tallow, on the trees about two feet above the ground. He discovered that the caterpillars could form bridges over the tallow, especially at night. Over the tallow he placed soft lard, which proved effective. He then swept the caterpillars off the branches on to the ground. The caterpillars attempted to ascend the tree again, but would not cross the greased band. While thus gathered between the bands and the ground they were destroyed in great numbers. To clean twenty-two thousand trees in this way it cost seven and one half cents per tree, and the work done in less than four weeks. Although the orchard is not thoroughly cleaned, Mr. DeLong saved the greater portion of his crop of twenty thousand trees for this season. These caterpillars can be effectively exterminated by carefully ex-

amining the young wood before the tree is leafed out, and picking off and destroying the bunches of eggs; also the picking off and destroying of any cocoons found on the trees—there is often found a leaf folded containing six or seven cocoons. However, Mr. DeLong is confident he can exterminate them next season, by placing the greased bands on the trees and shaking off the young caterpillars.

Fortunately, nature in this case also comes to the rescue, and in 1882 a small fly, belonging to the *Ichneumonidæ*, became numerous, and the year after it was hardly possible to find a caterpillar. A year ago, 1887, I visited the place, and but very few larvæ could be found. Specimens, however, have been sent from portions of Sonoma.

THE FALL WEB-WORM. (Figure No. 41.)

Hyphantria Cunea (Drury). Order, Lepidoptera; Family, Bombycidæ.

For the last two years, to my knowledge, the American black walnut trees (*Juglans nigra*), and also some few California walnuts (*Juglans californica*) growing on the streets in the town of Santa Cruz, have been infested with a hairy, brownish caterpillar spinning large tents. This year they have especially been numerous. After trying for some time, I finally succeeded in raising a moth, which has been identified by Mr. D. W. Coquilett as the true fall webworm, which is also well described in Professor Riley's report

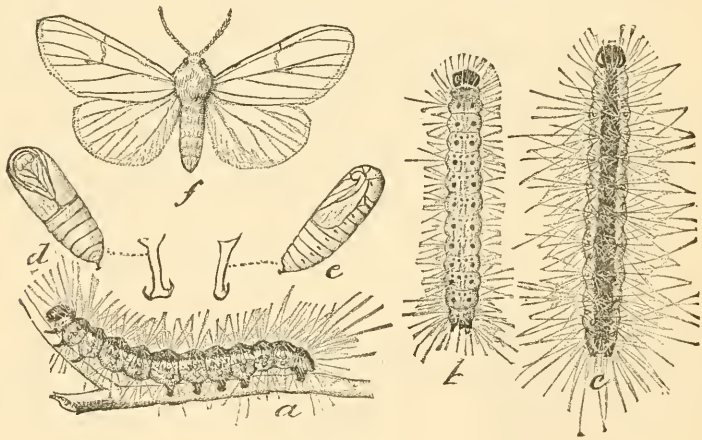

Figure No. 41.

for 1886. The insect has during the last years been very abundant in many portions of the East, and it seems there to have attacked a great variety of trees. I have not seen it feed in nature on any but walnut trees, in fact not on the so called English walnut (*Juglans regra*), although the tree is abundant in Santa Cruz. However, that it will feed on this species I am satisfied, as leaves of this tree fed in confinement were greedily eaten.

My poor success in raising so few moths is due to the happy fact that the insect has very numerous parasites, and were it not that these again are being destroyed by still smaller parasites, the fall webworm would soon be a thing of the past.

Of the parasites found among the debris of the webworm, one has been identified as the *Limneria pallipes* Prov., a hymnopterous parasite mentioned by Professor Riley as one of the principal destroyers of the fall webworm.

The following description is taken from Professor Riley's report of 1886:

Limitation of Broods.—At Washington I may say in general that the first brood appears soon after the leaves have fully developed, and numerous webs can be found about the first of June, while the second brood appears from the middle of July on through August and September. In Massachusetts and other Northern States the first moths issue in June and July; the caterpillars hatch from the last of June until the middle of August, reach full growth and wander about seeking places for transformation from the end of August to the end of September.

The species invariably hibernate in the chrysalis state within its cocoon, and the issuing of the first brood of moths is, as a consequence, tolerably regular as to time, *i. e.*, they will be found issuing and flying slowly about during the evening, and more particularly at night, during the whole month of May, the bulk of them early or late in the month, according as the season may be early or late. They couple and oviposit very soon after issuing, and in ordinary seasons we may safely count on the bulk of the egg being laid by the end of May. During the month of June the moths become scarcer, and the bulk of them have perished by the middle of that month, while the webs of the caterpillars become more and more conspicuous. The second brood of moths begins to appear in July, and its ocurrence extends over a longer period than is the case with the first or spring brood. The second brood of caterpillars may be found from the end of July to the end of September, hatching most extensively, however, about the first of August.

The following general remarks upon the different stages refer to Washington and localities where the same conditions hold:

The female moth deposits her eggs in a cluster on a leaf, sometimes upon the upper and sometimes on the lower side, usually near the end of a branch. Each cluster consists of a great many eggs, which are deposited close together and sparsely interspersed with hair-like scales. In three instances those deposited by a single female were counted. The result was three hundred and ninety-four, four hundred and twenty-seven, and five hundred and two, or an average of four hundred and forty-one eggs. But in addition to such large clusters each female will deposit eggs in smaller and less regular patches, so that at least five hundred eggs may be considered as the real number produced by a single individual. The egg, measuring 0.4 mm, is of a bright, golden-yellow color, quite globular, and ornamented by numerous regular pits, which give it under a magnifying lens the appearance of a beautiful golden thimble. As the eggs approach the time of hatching this color disappears and gives place to a dull, leaden hue.

The interval between the time of depositing and hatching of the eggs for the first brood varies considerably, and the latter may be greatly retarded by inclement weather. Usually, however, not more than ten days are consumed in maturing the embryo within. The eggs of the summer brood seldom require more than one week to hatch.

Without check, the offspring of one female moth might in a single season (assuming one half of her progeny to be female, and barring all checks) number one hundred and twenty-five thousand caterpillars in early fall—enough to ruin the shade trees of many a fine street.

The Larvæ.—The caterpillars just born are pale yellow, with two rows of black marks along the body, a black head, and with quite sparse hairs. When full grown, they generally appear pale yellowish or greenish, with a broad dusky stripe along the back and a yellow stripe along the sides; they are covered with whitish hairs, which spring from black and orange-yellow warts. The caterpillar is, however, very variable both as to depth of coloring and as to markings. Close observations have failed to show that different food produces changes in the coloration; in fact nearly all the various color varieties may be found upon the same tree. The fall generation is, however, on the whole, darker, with browner hairs, than the spring generation.

As soon as the young caterpillars hatch they immediately go to work to spin a small silken web for themselves, which by their united efforts soon grows large enough to be noticed upon the trees. Under this protecting shelter they feed in company, at first devouring only the green upper portions of the leaf, and leaving the veins and lower skin unmolested. As they increase in size they enlarge their web by connecting it with the adjoining leaves and twigs; thus as they gradually work downwards their web becomes quite bulky, and, as it is filled with brown and skeletonized leaves and other discolored matter as well as with their old skins, it becomes quite an unpleasant feature in our public thoroughfares and parks. The caterpillars always feed underneath these webs; but as soon as they approach maturity, which requires about one month, they commence to scatter about, searching for suitable places in which to spin their cocoons. If very numerous upon the same tree the food supply gives out, and they are forced by hunger to leave their sheltering homes before the usual time.

When the young caterpillars are forced to leave their web they do not drop suddenly to the ground, but suspend themselves by a fine silken thread, by means of which they easily recover the tree. Grown caterpillars, which measure 1.11 inches in length, do not spin such a thread. Both young and old ones drop themselves to the ground without spinning when disturbed or sorely pressed by hunger.

Pupa and Cocoon.—Favorite recesses selected for pupation are the crevices in bark and similar shelters above ground, in some cases even the empty cocoons of other moths. The angles of tree boxes, the rubbish collected around the base of trees, and other like shelters are employed for this purpose, while the second brood prefer to bury themselves just under the surface of the ground, provided that the earth be soft enough for that purpose. The cocoon itself is thin and almost transparent, and is composed of a slight web of silk intermixed with a few hairs, or mixed with sand if made in the soil.

The pupa is of a very dark-brown color, smooth and polished, and faintly punctuate. It is characterized by a swelling or bulging about the middle. It is 0.60 of an inch long and 0.23 of an inch broad in the middle of its body.

The Moth.—The moths vary greatly, both in size and coloration. They have, in consequence of such variations received many names, such as *cunea* (Drury), *textor* (Harr.), *punctata* (Fitch), *punctatissima* (Smith). But there is no doubt, as proven from frequent breeding of specimens, that all these names apply to the very same insect, or at most to slight varieties, and that Drury's name *cunea*, having priority, must be used for the species.

The most frequent form observed in the vicinity of Washington is white, with a very slight fulvous shade. It has immaculate wings, tawny-yellow front thighs, and blackish feet. In some specimens the tawny thighs have a large black spot, while the shanks on the upper surface are rufous. In many all the thighs are tawny yellow, while in others they have scarcely any color. Some specimens (often reared from the same lot of larvæ) have two tolerably distinct spots on each front wing, one at base of fork on the costal nerve and one just within the second furcation of the median nerve. Other specimens, again, have their wings spotted all over and approach the form *punctatissima*, described as the many-spotted ermine-moth of the Southern States. The wings of the moth expand from one inch and a quarter to one inch and three eighths. The male moth, which is usually a little smaller, has its antennæ doubly feathered beneath, while those of the female possess instead two rows of minute teeth.

The pupa state lasts from six to eight days for the summer brood, while the hibernating brood, however, requires as many months, according to the latitude.

I have given considerable space to the description of this insect as, judging from its increase in Santa Çruz, it may perhaps prove as great a nuisance as it has been in many portions of the East, where it two years ago especially defoliated nearly all the shade trees in Washington City.

Remedies.

The remedies recommended in the Eastern States might be used with advantage here:

Burning the nests as soon as they appear, with torches of rags soaked in kerosene.

A special and very handy kind of torch is recommended for the purpose, and is known as the brick torch.

Take a piece of soft brick, trim it to egg shape; then take two soft wires, cross them on the brick, wrapping them together round the opposite side so as to firmly secure it: now tie this end to a long stick by wrapping around it; then soak the brick in coal oil, light it with a match, and it is ready.

Arsenical Poisons.

Both Paris green and London purple are recommended, mixed with flour. When used early during the first appearance of the worms, it can be used stronger. I should not recommend to use it more than one pound to one hundred and eighty gallons of water, and London purple one pound to two hundred gallons.

TUSSOCK MOTH. (Figure No. 42.)

Orygia Leucostigma. Order, Lepidoptera; Family, Bombycidæ.

Figure No. 42.

The engraving gives a fair idea of the larva or caterpillar of the tussock moth, which is often found in orchards bordering on woods, especially in Santa Cruz and Sonoma Counties. The ground color of the larva is light yellow, sparingly clothed with fine yellow hairs on the sides of the body, and having four short and thick brush-like yellow tufts on the back, that is, on the fourth and three following rings; two long black plumes or pencils extending forward from the first ring, and a single plume on the eleventh ring. The head and the two little retractile warts on the ninth and tenth rings are coral red; there is a narrow black or brownish stripe

along the top of the back, and a wide dusky stripe on each side of the body.

The female is almost wingless, and for this reason their spreading is slow and could be entirely prevented by placing bands with sticky material which is used to capture the wingless female of the canker worm. As a general thing the damage is not very serious, and the caterpillars being very conspicuous they can easily be seen and destroyed. The eggs are laid on the cocoon and are covered with a large quantity of frothy matter, which, on exposure, becomes hard and brittle. The wingless female has a large heavy body, and is of a light gray color. The male has large gray wings marked with darker stripes.

THR RED-HUMPED CATERPILLAR.

Notodonta Concinna. Order, Lepidoptera; Family, Bombycidæ.

The name given to this insect is a very good one, being taken from its most characteristic point.

It has been reported in various portions of the State, and proved itself quite troublesome in certain parts of Sonoma for some seasons past, feeding principally in apple trees.

Evidently it has two broods in the season—perhaps three—as I saw it there in July, and specimens of the larvæ were sent to me again this fall. The insect is well known in the East and is well described by Harris. As it has not been mentioned here in any previous report, we take the liberty of copying from him. The eggs from which they proceed are laid in the month of July, in clusters on the under side of the leaf, generally near the end of a branch. When first hatched they eat only the substance of the under side of the leaf, leaving the skin of the upper side and all the veins untouched; but as they grow larger and stronger, whole leaves from the point to the stalk, and go from leaf to leaf down the twigs and branches. The young caterpillars are lighter colored than the old ones, which are yellowish brown, paler on the sides, and longitudinally striped with slender, black lines; the head is red; on the top of the fourth ring there is a bunch or hump, also of a reddish color; along the back are several short black prickles; and the hinder extremity tapers somewhat, and is always elevated at an angle with the rest of the body, when the insect is not crawling. The full grown caterpillars measure one inch and a quarter, or rather more, in length. They rest close together on twigs when not eating, and sometimes entirely cover small twigs and ends of branches. The early broods come and leave the trees by the middle of August, and the others between this time and the latter part of September. All the caterpillars of the same brood descend at one time, and disappear in the night. They conceal themselves under leaves or just beneath the surface of the soil, and make their cocoons, which resemble those of the unicorn (*Notodonta*). They remain a long time in their cocoons before changing to chrysalids, and are transformed to moths towards the end of June or the beginning of July. Mr. Abbott states that in Georgia these insects breed twice a year, the first broods making their cocoons towards the end of May, and appearing in the winged form fifteen days afterwards. This *Notodonta* is a neat and trim-looking moth, and hence is called *concinna*. It is of a light-brown color; the fore wings are dark brown along the inner margin, and more or less tinged with gray before; there is a dark-brown dot near the middle, a spot of the same color near each angle, a very small triangular whitish spot near the shoulders, and several dark-brown longitudinal streaks on the outer hind margin; the hind wings of the male are brownish or dirty white, with a brown spot on the inner hind angle. Those of the other sex are dusky brown; the body is light brown, with thorax rather darker. The wings expand from one inch to one inch and three eighths.

Remedies.

As they maintain their gregarious habits during their entire larval state, they can be gathered or destroyed either by cutting off the limbs they are on or by jarring the branches. When but a few caterpillars are seen handpicking will suffice. Where they are numerous spraying with Paris green, at the rate of one pound to two hundred gallons, would be useful. This caterpillar is especially fond of apple and plum leaves.

CHAPTER VII.

MISCELLANEOUS INSECTS FEEDING ON FOLIAGE.

Diabrotica soror—Remedies—Pear or cherry slug—Red mite or spider—Yellow mites—Remedies for mites.

THE CALIFORNIA (12) SPOTTED DIABROTICA.

Diabrotica Soror (Figure No. 43). *Order, Coleoptera; Fam., Chrysomelidæ.*

The *Diabrotica soror* is a very close relation of the D. 12 *punctata* which occurs in the East, and has often been mistaken for the same. Of all the leaf beetles found in the State, none is more destructive in certain localities and in certain seasons than this species.

The imperfect engraving gives an idea of its appearance. The head is black; the wing cases yellowish green, with twelve distinct black spots. Unfortunately, this insect is so common that it hardly needs to be described. Being often associated with two or three species of ladybugs, it is often thought by people to be one of them. A little closer examination will reveal the fact that it has four joints in the toes, while a ladybug has only three. It is to be regretted that we still are in ignorance of the manner this insect hibernates. The mature insect is found rarely during the winter, and the presumption is that eggs are laid on grasses and other plants during the fall, and that the larva feed on the roots of plants. The *Diabrotica* is especially bad near sandy watercourses and gravelly land, and its increase is always favored by the cultivation of corn and other vegetables in the orchard.

Figure No. 43.

Remedies.

It must be said that no very successful nor thorough remedy has been found for this pest, and I can only offer the partial remedies previously recommended; namely, spraying with Professor Riley's kerosene emulsion, but the spraying must be done early in the morning, when the insects are sluggish. This remedy can only be used when the insects appear early, while the fruit is still small. It will prevent the insects from destroying the leaves. Later on, fumigation seems to be the only practical way of driving them from the orchard. On the San Joaquin River, the striped squash bug (also a diabrotica) is kept at bay by lighting smudge fires, on which a little wood tar is placed. This method will probably prove as efficacious against the spotted diabrotica.

PEAR OR CHERRY SLUG.

Selandria Cerasi. Order, Hymenoptera; Family, Tenthredinidæ.

This insect takes its name from the resemblance in the larval state to a snail or slug. The parent is a small black fly, which deposits its egg on the upper surface of leaves, where it can be seen as a small white speck. The larva hatches from the egg in a few days, and commences to eat the green part of the leaf, leaving only portions of the epidermis. When full grown, it drops to the ground and transforms. Often three to four larvæ are found on the leaf. In such a case the leaf will be completely stripped, and when trees are badly infested the influence will be felt next year, fruit spurs being but imperfectly developed.

Remedies.

When these insects appear later in the season, the throwing of dust with a shovel on the tree, or better, air-slacked lime, is sufficient. But if they make their appearance early in the season, spraying should be resorted to, that all the eggs may be killed. For this purpose the sulphide of soda and soap wash is excellent.

PEAR TREE SAW FLY.

Nematis Species.

This insect is closely allied to the former, but its mode of attack is different. While the pear slug devours only the fleshy part, this insect eats the whole blade of the leaf, leaving often only the ribs.

The eggs are laid in a slit in the leaf, cut by the ovipositor of the female. The young larva eats a hole through the leaf and keeps enlarging this as it grows. The larva full grown measures half an inch in length, has thoracic legs, twelve pro legs, and two anal pro legs; the general color, greenish yellow; eyes, black.

The adult insect is described by the late M. Cooke as having a span of wings of three fifths of an inch, the body three tenths of an inch in length; the upper part of the head and thorax black; abdomen yellow, with black transverse bands on dorsal half of each segment; wings clear, of a brownish hue.

Remedies.

Spraying with paris green, at the rate of one pound to one hundred and eighty gallons of water, is a good remedy; if this is objectionable, white hellebore, one teaspoonful to a bucketful of water, is reported as doing good service.

RED SPIDER OR MITE.

Tetranychus Telarius.

This insect is probably a native of the State, as I have found it almost everywhere on wild bushes and weeds, and very few orchards are truly exempt from it. It is found on evergreen as well as deciduous trees, and is, especially in dry seasons, and in localities where the air is dry, quite a formidable pest.

The varieties of trees most affected by it are the almond and the prune, but many varieties of plum suffer severely, as well as pears and apples. The mite hatches in the springtime, often with the expanding first leaves and blossoms, from eggs laid in the fall of the year, and just before hatching turn a very bright red, which, when they are numerous, color the trunk red; the empty cases remain on the tree and are transparent white. Unfortunately all insects do not hatch at once, but in course of many weeks, and this makes their total destruction very difficult, as when in the egg state they are extremely hard to kill.

The larva of the red spider has only six legs, but, after having pupated, it comes out a perfect insect with eight legs.

The red spider injures the leaves and the tender twigs by eating portions of the epidermis, and being very numerous, soon cause the leaves to lose their bright color; they become of an ashen hue—a very characteristic mark of the presence of the mite.

YELLOW MITES.

In the interior of the State a yellow species of mite is often found doing much damage to pear trees. The remedies adopted for the red spider are equally as effectual. Young nursery stock attacked has been kept very clean by frequent sprayings of cold water.

Remedies.

To destroy this insect in the egg state is a very hard matter, anything found strong enough damaging the tree. We have, therefore, to resort to washes during the summer or spring. For this purpose sulphur washes seem especially adapted. We know of nothing better than the sulphide of soda and soap wash, applied copiously to the tree as soon

as the insects make their appearance. Two washings, at least, are necessary to do efficient work. Many prefer a washing after the fruit is off; I should prefer one in June and another in September.

The most successful cleaning of tree for the red spider I have lately observed is where abundance of sulphur was used in the solution, in fact, as much as could be carried in the solution—about five pounds to the one hundred gallons; when difficulty is experienced to get such quantity through the nozzle, the San José nozzle, with rubber substituted for the brass disk, is the best.

CHAPTER VIII.

BENEFICIAL INSECTS.

Ladybirds or bugs—The brown-necked ladybug—Lace-wing flies—Podabrus beetles—Syrphus flies.

THE LADYBIRDS OR BUGS.

Coccinellidæ.

The usefulness of the ladybugs in destroying aphis of all kinds is familiar to most persons having observed these pretty little insects. Yet the very great role they play in keeping the myriads of aphis and scale insects in check is not as fully appreciated by many as it ought to be. Indeed, were it not for the interference of those insects, the very ground would be covered with aphis, and our grain, flowers, and fruit trees destroyed by the various numbers of the homoptera or true bugs.

Among insects very conspicuous for their predaceous habits, I have especially had occasion to observe four families of insects. These are true beetles undergoing the usual transformation of the highly developed insect. The eggs are yellow, somewhat pointed, and laid in bunches on bark and leaves of trees or plants. The larva produced from this is a curious little creature, soft, worm-like, tapering to both ends, is provided with six legs, and is quite active. Some of the larva, as the ordinary ladybugs of the genus *Coccinella*, are naked bluish, with yellow spots; others, like *Scymnus*, are covered with short hairs, and those of the *Chilocorus* are provided with soft black spines. It is in the larval state that these insects do the most good. Thus it was larva I found feeding inside the egg-sac of the fluted scale.

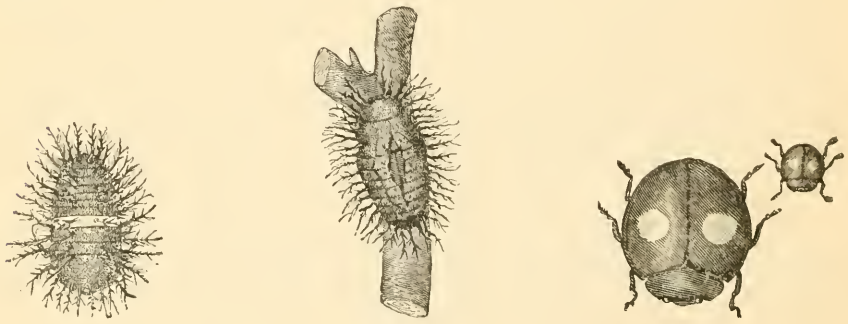

Figure No. 14.

It is in the larval state that the *Chilocorus*, or black red-spotted ladybug, does its best work feeding on the various scale insects, and it does its work sometimes so thoroughly that in some instances the scale has been appar-

ently exterminated. In this State we have a number of ladybugs belonging to the genus *Coccinella* and *Hippodamia*. These, as a general thing, feed on aphis of all kind in their larval state, but are also very active in the imago state feeding on woolly aphis.

The *Chilocorus* has been referred to and the figure shows it in its various stages from larva to imago. The chrysalis shows the characteristic appearance of most ladybugs. The *Chilocorus bivulneris* is the most common species, having been observed from Shasta to San Diego. Preying on the native scales of the woods, it has gradually extended its operations to the orchards, and is met with in nearly every infested district and has probably done more good than any other species, unless it should be its modest and obscure little cousin, the brown-necked ladybug, to which we draw special attention.

THE BROWN-NECKED LADYBUG. (Figure No. 45.)

Scymnus Marginicollis.

Figure 45.

From time to time attention of entomologists has been drawn to the members of the genus which all seem to have proved themselves very useful in preying on various scale insects, and even on phylloxera. In California the species figured above, *Scymnus marginicollis*, is quite common. In an article in the "Pacific Fruit Grower," Mr. D. W. Coquillett proposes the name brown-necked ladybug, and speaks of the larva having been found by Mr. A. S. Chapman and I on his place at San Gabriel feeding on the eggs of *Icerya purchasi*.

The larvæ of the species are of the usual form of ladybug larvæ. The body is of yellowish-gray color, thickly covered with a white, mealy powder, which is gradually rubbed off, and with a covering of white matted hair; their heads are of a pale yellow color. They pass through the chrysalis form in about a week, and appear as fully developed ladybugs. Its head and throat are reddish brown. The wing cases are black, but covered with peculiar whitish hair, which are turned in the manner shown in figures. In the summer time, especially in a dusty country, fine particles of dust adhere to these and gives the insect a gray color so closely resembling the bark that they can only be noticed by looking very sharp for them.

I have often heard it stated that much damage has been done by the ladybug, and have indeed often seen them helping the diabrotica to devour overripe fruit and eating up the squash vines. It should be remembered by those people who have complained bitterly over the harm done by them, that were it not for their presence there would have been no squash vines to eat and no leaves or fruit on the trees, as the aphis would have destroyed them. As a general thing little damage is done by the ladybug as compared with the good it does, as it is only ripe fruit that suffers.

LACE-WING FLY (Figure No. 46).

Chrysopa Species.

The engraving (Figure 47) shows the larva of this useful insect, which has been called aphis lion, on account of its great appetite for these insects. It is of grayish color, banded with white. The eggs are very conspicuous, planted as they were on a long stalk, resembling certain kinds of mold. The adult insect is delicate looking, with large transparent wings, large

Figure No. 46.

Figure No. 47.

golden eyes (hence the name *Chrysopa*). It is seen flying lazily around infected trees or plants.

The larva of the *Chrysopa* is known to devour fruit and vegetables, but this is an exception, it being a great help in the extermination of aphis, and we recall the fact of their usefulness in South Africa, in preying on the fluted scale, a habit they have sparingly taken to in this State also.

PODABRUS BEETLES.

The *Podabrus* is a genus of beetles, which also have several members which play an important part in keeping the aphidians in check. In Berkeley I have observed them to be very numerous certain seasons; large patches of grain being cleaned of aphis chiefly by their agency. The *Podabrus* is readily known by its yellow feathery antennæ, yellow legs and body, and black wing covers. Their flight is slow, and they are readily caught when hovering over the grain.

SYRPHUS FLIES.

The appetite of the blind larvæ of these insects is something enormous. This spring, when they were found very abundant, feeding upon the plum aphis, I took home at noon two leaves covered with the aphis and with two larvæ on each, and left them on a table. In the evening I examined the leaves, and found nothing but empty skins of aphis. The aphis had all been devoured by the syrphus larvæ, and these were still hungry for more. In Mr. Hubbard's report of insects injurious to the orange, I find the following precise and interesting description of the syrphus flies:

Whenever colonies of aphis are found on the orange there will almost invariably be found among them slug-like larvæ, which creep about among the plant lice with a leech-like movement, now contracting into an almost globular mass, and again elongating like the joints of a telescope. The minute terminal joint, which constitutes the head of the larvæ, is observed to possess a pair of retractile, horny hooks, which work forwards and back, in and out of the mouth, like a rake. As the larva advances with a groping motion, for it is quite blind and eyeless, the outstretched head and neck sweep the surface, and the jaws continue their raking movement until they strike the body of an aphis. Immediately the jaw-hooks grapple their unresisting victim, and soon through the transparent walls of the body the sucking stomach is seen pulsating and drawing through the œsophagus, in a continuous stream, the green juices of the plant louse.

When actively engaged in feeding these larvæ continue with the greatest voracity to empty one louse after another, until they have destroyed dozens of them; and their bodies distended with the contained juices become translucent green in color. When filled to repletion, the larva falls into lethargy, lasting two or three hours; during which the processes of digestion change the juices of the body to varying shades of brown, and dark masses of fecal matter gradually form in the intestines. The curious changes of color in the semi-transparent larvæ are therefore due entirely to the condition of the body contents. The full fed individuals usually have a tinge of flesh color, owing to the formation of glandular, creamy masses of fat, which have a roseate hue. When fasting through scarcity of food the fat is absorbed, and the body becomes dark brown and opaque. When feeding, the larva is translucent green; while digesting, the colors change to olive and brown, with distinct markings of reddish brown and black.

Transformations.—When full fed, the larva attaches itself by means of a pair of terminal prop legs, aided by a viscid secretion which it voids, and which, in drying, glues it to the surface of the plant. The body becomes distended and thickened, losing in length what it gains in girth. The skin of the larva is not split or shed, but hardens and forms the puparium, which protects the true pupa within. In the puparium the shape of the larva is profoundly altered, the body joints are obliterated, the anterior end becomes swollen and broadly rounded, and the form tapers suddenly behind.

The perfect fly issues by pushing off the convex end of the puparium, which splits at the suture between two of the old larval joints, and releases a circular cap in the shape of a watch-glass.

The duration of the egg and larval periods of these aphis-eating flies is short; the egg hatches in forty-eight hours after it is laid, and the larva becomes full grown and forms its pupa in five or six days. About ten days, the average time of insects having many broods, are passed in pupa. The reason of this extremely rapid development in the first two stages —the egg and larva—becomes obvious when we consider how brief is the existence of the aphis itself, and how suddenly its colonies appear and disappear—for the life of a colony of aphis is also very short. Upon the orange the aphis can feed only on the very tender young leaves; in a short time these harden, and then the colony must scatter; but frequently long before that time their numbers are reduced almost to extermination by enemies and parasites. As the syrphus larvæ cannot follow the winged insects, they must make the best of their limited opportunities and feed quickly or perish of starvation. It is curious to mark how nature in the case of these insects has responded to the necessities of the situation and given their larvæ restless activity, great rapacity, and destructive powers, notwithstanding their slow locomotion, and also a remarkably brief egg period, so that this wingless, blind, and almost legless maggot is enabled to compete with more perfectly organized rivals in the food struggle which takes place over every aphis colony.

Broods, etc.—The larvæ of these syrphus flies feed only upon aphis, and depend upon them for their existence. They therefore appear and disappear with the colonies of the latter, and the broods may be supposed to follow rapidly one upon another during the seasons of growth, when the appearance of new shoots upon the orange gives support to numerous colonies of aphis.

The seasons of growth in the orange, after the renewal of the folage in the early spring, depend in a great measure upon the prevalence of rains, and vary from year to year, but are usually three or four in number during the year. The colonies of aphis, and likewise their syrphus enemies, are most abundant in June and September.

Three representatives of the family *Syrphida* are found among aphis on the orange. They belong to the genus *Baccha*.

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